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# NUCLEAR SCIENCE ABSTRACTS

## CHEMISTRY

### Analytical Chemistry

*Refer also to abstracts 28783 and 31059.*

**28673** (UCRL-50006-69) 1968 ANALYTICAL CHEMISTRY ANNUAL REPORT. Harrar, J. E. (comp. and ed.) (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 18, 1969. 63p. Dep. CFSTI.

ALUMINUM ALLOYS AND SYSTEMS—electron microprobe studies on, anodized in sulfuric acid
ATMOSPHERE—analysis for helium and krypton, design of gas chromatograph for
BERKELIUM-249—spectra in sulfuric acid, solution absorption
BORON—analysis for impurities, comparison of methods for
CARBON—determination of trace amounts of, by ion bombardment
EINSTEINIUM-253—spectra in gadolinium iodide, emission —spectra of ionic, in lanthanum trichloride, luminescence
ETHYLENE POLYMERS—determination in plastic-bonded explosives containing HMX and potassium perchlorate, method for
FLUORIDES—uses in chemical analysis
FLUORINE—determination in presence of potassium sulfate by titration with thorium nitrate
GAS CHROMATOGRAPHY—equipment design for determination of helium and krypton in atmosphere —equipment design for determination of trace amounts of gases
GERMANIUM—analysis of single crystals of semiconductor, for impurities, electron microprobe
HAFNIUM—determination in rhenium-tungsten and molybdenum-rhenium-tungsten alloys, spectrographic —determination in hafnium-molybdenum alloys by x-ray fluorescence
HYDROGEN—analysis for deuterium and deuterium hydride by gas chromatography
LEAD—determination in silver and silver alloy tubes, electron microprobe
MANGANESE—determination in pyrophosphate media by controlled-potential coulometry
MOLYBDENUM—determination in molybdenum-rhenium-tungsten alloys by x-ray fluorescence —determination in molybdenum-rhenium-tungsten alloys by controlled-potential coulometry
NITROGEN—determination in lithium by distillation and flow spectrophotometry
PENTAERYTHRITOL TETRANITRATE—relaxation processes in crystals of
PENTANE, 1,5-DIFLUORO-3,3-DIMETHOXY-1,1,5,5-TETRANITRO-—analysis of, gas chromatographic
POTASSIUM PERCHLORATES—determination in plastic-bonded explosives containing HMX and polyethylene, method for
RHENIUM—determination in molybdenum-rhenium-tungsten alloys by x-ray fluorescence
ROCKS—analysis for rare earths, scandium, and yttrium, spectrographic —analysis for trace elements, atomic absorption spectrophotometry —analysis for rare gases, design of apparatus for
SILVER—analysis of tubes of, for elements, electron microprobe
SILVER ALLOYS AND SYSTEMS—analysis of tubes of, for elements, electron microprobe
SOILS—analysis for rare gases, design of apparatus for
SPECTROGRAM COMPARATORS—computer control of, for data acquisition from emission spectral plates
STEEL—analysis of different types of, electron microprobe
1,3,5,7-TETRAZOCINE, OCTAHYDRO-1,3,5,7-TETRANITRO-—determination in plastic-bonded explosives containing polyethylene and potassium perchlorate, method for —stability of δ-polymorph of
TITANIUM—determination in titanium-tungsten alloys by atomic absorption spectrophotometry
p-TOLUIDINE, N,N-DIMETHYL-—determination of, method for photometric
TUNGSTEN—determination in molybdenum-rhenium-tungsten alloys by x-ray fluorescence
WATER—determination in polystyrene by Karl Fischer titration
ZINC—determination in silver and silver alloy tubes, electron microprobe (P.C.S.)

**28674** PROCEEDINGS OF THE XXXVII MEETING OF THE ISRAEL CHEMICAL SOCIETY, THE ISRAEL BIOCHEMICAL SOCIETY, AND THE ISRAEL INSTITUTE OF CHEMICAL ENGINEERING, HELD AT BEERSHEBA, OCTOBER 8–10, 1968. Stein, G. (ed.). Israel J. Chem., 6: 1p-147p(1968). (CONF-681054-(Abstr.)).

Abstracts of papers are presented in the fields of organic chemistry, inorganic and analytical chemistry, physical chemistry, chemical engineering, and biochemistry. Specific topics included are: separation of various oxidation states of aqueous iodine-131 solution by paper chromatography; extraction of thorium nitrate by hexanol; the stretching frequencies of isotopic sodium permanganates in aqueous solutions; the isotope exchange reaction $^{12}C^{18}O + {}^{13}C^{16}O \rightleftharpoons {}^{13}C^{18}O + {}^{12}C^{16}O$ single pulse shock tube studies; pulse radiolytic studies on the formation and disappearance of Cu(III); $^{17}O$ hyperfine splitting of the $PO_3^{-2}$ radical trapped in a single crystal of $Na_2DP^{17}O_3 \cdot 5D_2O$; the homogeneous exchange reaction between deuterium and ammonia, single pulse shock tube studies; ir spectra of methane and deuteromethane trapped in rare gas matrices; quick balance of mercury in electrolytic cells by using radioactive mercury; separation of xenon isotopes by thermal diffusion; and effects of physical activity on the cesium and potassium content as detected by human whole body counting. (D.H.M.)

**28675** BIOCHEMISCHE ANALYTIK, TAGUNG VOM 29.4–2.5 1968 IN MUENCHEN. (Conference on Analytical Biochemistry, Munich, April 29–May 2, 1968). Fresenius, W. (ed.). Z. Anal. Chem., 243: 1-840(1968). (CONF-680459).

Ninety-seven papers are included; separate abstracts were prepared for 8 of them. The remaining papers include information on: coulometry, NMR and mass spectroscopy, and thermoanalysis; ir spectroscopy, x-ray fluorescence, and emission analysis; isotopic methods; atomic absorption spectrophotometry; enzymatic analysis; methods for hormones and vitamins; gas chromatography; immunochemical analysis and isolation methods by means of gel filtration and carrier substances; progress in chromatographic methods; progress in electrophoretic methods; application of chromatographic methods; application of electrophoretic methods; special enzymology; and automation methods in analysis, statis-

tics, and quality control. An introduction paper on trend of development in biochemical analysis is also given. (P.C.H.)

*For abstracts of individual papers see: 28699, 28700, 28727–28731, and 28754.*

**28676** RARE-EARTH ELEMENTS IN XENOTIMES FROM KAWABE AND KARASUGAWA MINE, FUKUSHIMA PREF., JAPAN. Wakita, Hisanobu; Nagashima, Kozo (Tokyo Univ.). Kobutsugaku Zasshi, 9: 92-8(Oct. 1968). (In Japanese).

Rare earth elements in xenotimes were determined by chemical analysis and x-ray fluorescence analysis. On the basis of analytical results, the chemical formulas of xenotimes from Kawabe and Karasugawa Mine are as follows: $(Y_{0.681}, Zr_{0.118}, Th_{0.022}, \text{etc.})_{0.921}(P_{0.880}, Si_{0.283})_{1.083}O_4$ for Kawabe Mine, $(Y_{0.715}, Zr_{0.101}, Th_{0.011}, \text{etc.})_{0.907}(P_{0.806}, Si_{0.288})_{1.094}O_4$ for Karasugawa Mine. In x-ray fluorescence analysis, the standard sample and an unknown sample were mixed respectively with $SrCO_3$ of the same weight, and fluorescence spectra of the mixtures were measured. Using the L line as an analytical line, all the rare earth elements from La to Yb, except Pm and Lu, were determined in the unknown samples from a comparison of line intensities of both mixtures. The most abundant element was Dy and amounted to 24 and 23.6% of atomic ratio in total lanthanides in the samples from Kawabe and Karasugawa Mine, respectively. From the relation between the atomic number and the content of each element, both samples can be classified as thalenite. (NSA of Japan)

## Chemical Procedures

*Refer also to abstracts 28961, 28986, 29249, and 29494.*

**28677** (IN–1275) ANALYSIS OF IRRADIATED ZIRCONIUM CLAD THORIUM TUBES. Fluegel, J. E.; Wade, M. A.; Fortsch, E. M. (Idaho Nuclear Corp., Idaho Falls). Apr. 1969. Contract AT(10-1)-1230. 19p. Dep. CFSTI.

Four irradiated and two unirradiated zirconium-clad thorium tubes were dissolved and analyzed for uranium and thorium. The zirconium cladding was removed by dissolution in hydrofluoric acid. An insoluble double salt of zirconium and thorium was converted to the hydroxide of zirconium and thorium with sodium hydroxide and then dissolved with fuming perchloric acid. The thorium core of the sample was dissolved in nitric acid catalyzed with hydrofluoric acid. Thorium in the HF–Zr fraction was determined by emission spectroscopy and found to be negligible. Thorium in the dissolved residue fraction was determined gravimetrically after precipitation as oxalate and ignition to the oxide. Thorium in the $HNO_3$–Th fraction was determined volumetrically. Uranium was determined by isotopic dilution mass spectrometry after separation from the thorium and zirconium. (M.C.G.)

**28678** (JEN–202-DQ/I-69) QUANTITATIVE SPECTROGRAPHIC DETERMINATION OF TRACES OF MANGANESE IN FERRIC OXIDE. Capdevila, C.; Roca, M. (Junta de Energia Nuclear, Madrid (Spain). Direccion de Quimica e Isotopes). 1968. 11p. (In Spanish). Dep.

In order to enhance the sensitivity, different electrode types and sweeping substances were studied. Graphite anodes, with 5 × 2.5, 4 × 4.5, 4 × 8 and 7 × 10 mm craters, as well as $CuF_2$, AgCl, ZnO, and graphite powder as sweeping materials, were tested. A JACO-Ebert grating spectrograph and 10-amp dc arc were employed and the proper exposure times chosen from moving-plate studies. Using 4 × 4.5 mm electrodes and 75% AgCl a detection limit of 0.2 ppM is attainable. (auth)

**28679** (LA–4127) SPECTROCHEMICAL DETERMINATION OF YTTRIUM IN TANTALUM METAL AND TANTALUM–TUNGSTEN ALLOYS. Simi, Oliver R.; Phelps, Robert T. (Los Alamos Scientific Lab., N. Mex.). Dec. 1968. Contract W-7405-eng-36. 10p. Dep. CFSTI.

A spectrochemical method was developed for determining 1 to 100 ppM of yttrium in tantalum metal and tantalum-tungsten alloys. The sample is ignited to oxide and then mixed with an equal weight of graphite powder containing lanthanum as the internal standard. A 15-mg electrode charge is excited by a dc arc in an Ar–$O_2$ atmosphere. The spectrum is photographed with a 3.4-m Ebert-mounting spectrograph having a reciprocal linear dispersion of 2.5 Å/mm. The yttrium concentration is evaluated by photometric measurements of the line pair Y II 3710.30 Å and La II 3725.05 Å. Concentrations of 5 to 40 ppM are determined with 8% relative standard deviation. The presence of 10% tungsten or 500 ppM each of 14 impurity elements has no effect on the yttrium/lanthanum intensity ratio. Preparation of the sample and standards by an alternative technique verified the recommended procedure. (auth)

**28680** (NIM–92/14) DETERMINATION OF URANIUM BY THE TBP METHOD. Steele, T. W.; Taylor, J.; Summerson, C. D. (National Inst. for Metallurgy, Johannesburg (South Africa)). Oct. 28, 1967. 7p. Dep.

A method for determining uranium that involves the formation of a uranyl thiocyanate complex of uranium in the presence of EDTA and sodium formate, the extraction of the complex into tributyl phosphate (TBP), and the measurement of the transmittancy of the solvent phase are presented. The procedure is applicable to ore samples, filter cakes, and solutions of low uranium content. (D.H.M.)

**28681** (ORO–3518-11) EMF, VOLTAMMETRIC AND SPECTROPHOTOMETRIC MEASUREMENTS ON THE U(IV)/U(III) COUPLE IN MOLTEN LiF–$BeF_2$–$ZrF_4$. Jenkins, H. W.; Mamantov, G.; Manning, D. L.; Young, J. P. (Tennessee Univ., Knoxville. Dept. of Chemistry. Oak Ridge National Lab., Tenn.). Jan. 24, 1969. Contract AT(40-1)-3518. 2p. (CONF-690506–2). Dep. CFSTI.

From 135th National Meeting of the Electrochemical Society, New York.

Potentiometric determination of the U(IV)/U(III) ratio requires the value of the standard electrode potential of the U(IV)/U(III) couple relative to the standard electrode potential of a reference couple. The standard potential of the U(IV)/U(III) couple was calculated with respect to a hypothetical unit mole fraction Ni/Ni(II) electrode from emf measurements on the galvanic cell Pt/U(IV), U(III)//Ni(II)/Ni. The cell potential was measured as a function of the U(IV)/U(III) ratio which was varied by controlled reduction of U(IV) to U(III) with a Zr rod immersed in the solution. The U(IV) and U(III) concentrations were determined spectrophotometrically. A simple voltametric method was also developed for the determination of the U(IV)/U(III) ratio, when U(IV) ≫ U(III). The method involves the measurement of the potential difference between the equilibrium potential of the melt, measured by an inert Pt electrode immersed in the melt, and the voltammetric equivalent of the standard potential of the U(IV)/U(III) couple, $E_{\frac{1}{4}}$. (D.H.M.)

**28682** FLUOROMETRIC DETERMINATION OF EUROPIUM WITH BENZOYLTRIFLUOROACETONE. Shigematsu, Tsunenobu; Matsui, Masakazu; Sumida, Takayuki (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ., 46: 249-55(Nov. 1968).

Determination of traces of europium as benzoyltrifluoroacetone chelate was studied. The trioctylphosphine oxide adduct of the chelate, which has a fluorescence maximum at 612 mμ, was formed in n-hexane solution by utilizing synergistic effect in solvent extraction. The effect of various factors on the fluorescence intensity at 612 mμ was examined. This method made possible the detection europium in a concentration as low as $2 \times 10^{-8}$ M (or $3.04 \times 10^{-2}$ μg per 10 ml). Of the other rare earth ions, only samarium gave a positive error. Other common di- and tervalent cations had little effect except ferric ion which caused a negative error. (auth)

**28683** ANALYTICAL APPLICATIONS OF ANTHRAGALLOL [1,2,3-TRIHYDROXYANTHRAQUINONE] AND ANTHRAPURPURIN. I. QUALITATIVE. Capitan-Garcia, F.; Roman-Ceba, M. (Univ., Granada, Spain). Inform. Quim. Anal., Pura Apl. Ind., 21: 208-18(1967). (In Spanish).

The behavior of anthragallol and anthrapurpurin towards 48 ions, in different media, has been examined. Both reagents show little selectivity, although the latter is rather more selective in neutral media. However, they are very sensitive, particularly the latter, to some cations, viz., those of Al, Th, $V^V$, Cd, Y, $Ni^{II}$, Ca, Mg, $Bi^{III}$ and Ge (in concn. of 2 ppM or less). (Anal. Abstr.)

**28684** [VECTOR-]POLAROGRAPHIC DETERMINATION OF TRACES OF SELENIUM IN PURIFIED TELLURIUM AND IN ORES. Pats, R. G.; Semochkina, T. V. Zavod. Lab., 33: 1491-3(1967). (In Russian).

Procedures are given for the determination of Se in ores containing 10 to 100 ppM of Se. The sample is dissolved in $HNO_3$ and evaporated (during this process 12% of the Se is lost). After removal of $PbSO_4$ the Se is co-precipitated with $Fe(OH)_3$ at pH to 8.5. The separated precipitate (containing >5 mg of Fe) is dissolved in $H_2SO_4$ and then diluted. An aliquot is shaken for a few min with mercury to reduce the $^{34}Fe$ and the acidity is adjusted. Deposition of HgSe in a stationary mercury drop is carried out at −0.6 to −0.8 V, and the height of the dissolution peak at −0.9 V is measured. A method for determining Se in Te containing 0.1 to 1 ppM Se is given. The sample is dissolved in HCl–$NHO_3$ and evaporated (≃7% of the Se is lost at this stage). Deposition of Se at −0.3 V is followed by vector polarographic recording of the dissolution peak at −0.52 V. (TSS)

**28685** PULSE-POLAROGRAPHIC DETERMINATION OF TELLURIUM IN ARSENIC AND ARSENIC-CONTAINING PROD-

UCTS. Belikova, T. E.; Kaplan, B. Ya.; Shiryaeva, O. A. (State Scientific-Research and Planning Inst. of the Rare-Earths Industry, Moscow). Zavod. Lab., 33: 1365-7(1967). (In Russian).

Three procedures are given for determining Te in arsenic and arsenic-containing products: the first is for the determination of Te in As, gallium arsenide, and indium arsenide after concentration on S (sensitivity $\simeq 2 \times 10^{-6}$% Te); the second for the determination of Te in As after volatilization of As as $AsCl_3$; and the third is for the determination of Te in gallium arsenide alloyed with Te after formation of polarographically inactive As(V) (with 0.002% of Te, the coefficient of variation <8%). (TSS)

**28686** CATALYTIC DETECTION AND DETERMINATION OF IODINE TRACES WITH THE HELP OF THE 3,3'-DIMETHYLNAPHTHIDINE REACTIONS WITH HYDROGEN PEROXIDE. Bognar, Janos; Nagy, Lajos (Technische Univ., Miskolc, Hungary). Mikrochim. Acta, No. 1, 108-12(1969). (In German).

The 3,3'-dimethylnaphthidine–hydrogen peroxide redox reaction is strongly catalyzed by iodide. Therefore, if formic acid is present, iodide itself may be detected or determined at concentrations above 0.002 μg/ml. The simultaneous comparation method is appropriate. In the concentration region from 0.1 to 0.01 μg $I^-$/5 ml, the relative error is 3%. $Ag^+$, $Hg^{2+}$, or $Bi^{3+}$ may not be present. Other interfering ions can be masked with EDTA or tartaric acid. (auth)

**28687** ANALYTICAL APPLICATIONS OF ANTHRAGALLOL [1,2,3-TRIHYDROXYANTHRAQUINONE] AND ANTHRAPURPURIN. III. SPECTROPHOTOMETRIC DETERMINATION OF THORIUM WITH ANTHRAPURPURIN. Capitan-Garcia, F.; Roman Ceba, M. (CSIC, Granada, Spain). Ars Pharm., 8: 399-404(1967). (In Spanish).

A neutral solution containing Th(IV) (7 to 21 ppM) is treated with ethanolic anthrapurpurin (0.61 g per litre), and set aside for 2 hr.; the extinction is then measured at 540 nm. The Th content is calculated with reference to a calibration graph. The error is 0.93%. (Anal. Abstr.)

**28688** DETERMINATION OF MICROGRAM CONCENTRATION OF URANIUM IN THE URINE OF PERSONNEL IN URANIUM ORE CONCENTRATION PLANT BY MEANS OF CHLOROPHOSPHONAZO I. Pehr, Frantisek, Nosek, Jaroslav. Prac. Lek., 21: 112-15(Apr. 1969). (In Czech).

Estimation of the uranium content in urine of workers employed in a chemical processing plant for uranium ore was carried out. Workers were divided into groups according to the character of their work; for every group the average values and significant deviations were calculated. Estimation was achieved by the following means: after mineralization of the urine sample by nitric acid and hydrogen peroxide, uranium was extracted into an organic phase containing tributyl phosphate. Phosphates, in the presence of which the extractability of uranium complexes is decreased, were bound in the water phase by ferric nitrate. After washing of the organic phase by diluted nitric acid, uranium was reextracted into the water phase and after neutralization the uranium content was estimated by the organic agent Chlorphosphonazo I. The uranium content in urine of workers from the uranium ore chemical processing plant varied within a wide range from one to 50 μg uranium/l urine (threshold of maximum permissible concentration). Only in one case the amount of 62 μg uranium/l urine was found. (auth)

**28689** COULOMETRIC TITRATION OF MICROGRAM AMOUNTS OF AMERICIUM AT THE CONDUCTING GLASS ELECTRODE. Propst, R. C. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Anal. Chem., 41: 910-14(June 1969).

Coulograms of Am(III) in 0.1M $LiClO_4$–0.05M $Na_2CO_3$ electrolyte exhibit a well-defined wave for the Am(III)–Am(V) oxidation step at the conducting glass electrode. This wave provides the basis of a method for the quantitative titration of this element at the 30-microgram level with a precision of 1.5%. The method is restricted to pure solutions. Most cations interfere: Pu, Np, U, and Ru are reduced near the Am(III)–Am(V) wave. Fe precipitates and scavenges Am. Radiolysis products from radioelements also interfere. $SO_4^{2-}$ produces an anodic shift, and $F^-$ damages glass surfaces. $Cl^-$ or $NO_3^-$ do not interfere at 0.01M. Corrections are required for the partial oxidation of Am(V) to Am(VI) and the reduction of Am(VI) by water. The useful pH range is 10.0 to 11.5. The Am(III)–Am(V) couple is indicated to be irreversible. (auth)

**28690** ELECTROLYTIC DISSOLUTION OF TANTALUM, NIOBIUM, AND OTHER REFRACTORY METALS. Aladjem, Abraham (Soreq Research Center, Yavne, Israel). Anal. Chem., 41: 989(June 1969).

A method is described for the dissolution of Ta, Nb, W, Zr, V, Hf, Ti, and their alloys in a 5% solution of $NH_4Cl$ in methanol. The dissolution is carried out in borosilicate glass containers, without separation of anolyte from catholyte Ta or Pt wire 0.4 mm in diameter is used as the cathode. In some cases chemical analysis may be continued directly in the methanol solution (preliminary experiments show that colorimetric measurements are possible in such solutions), but in general the methanol is evaporated and the residue is dissolved in the aqueous medium needed for subsequent analytical steps, and separation or determination of impurities is carried out by conventional methods. (P.C.H.)

**28691** DIRECT READING SPECTROCHEMICAL DETERMINATION OF TRACE ELEMENTS IN SILICATES INCORPORATING AUTOMATIC BACKGROUND AND MATRIX CORRECTIONS. Tennant, W. C.; Sewell, J. R. (Dept. of Scientific and Industrial Research, Wellington, New Zealand). Geochim. Cosmochim. Acta, 33: 640-5(May 1969).

Details are given of a direct reading dc arc spectrochemical procedure for the determination in geochemical samples of the elements B, Be, Cr, Cu, La, Mn, Mo, Ni, Pb, Sn, V, Y, and Zr in amounts down to 1 ppM. Automatic background and matrix corrections are achieved by complementary buffering and exposure to constant background. A coefficient of variation of better than ±5% of the element content is normally attained. (auth) (UK)

**28692** PHOTOMETRIC DETERMINATION OF MOLYBDENUM AFTER ITS EXTRACTION WITH MONO-2-ETHYLHEXYLPHOSPHORIC ACID. Kletenik, Yu. B.; Bykhovskaya, I. A.; Sekretova, L. V. (Inst. of Physico-Chemical Principles of the Treatment of Mineral Raw Materials, Novosibirsk, USSR). Zh. Anal. Khim., 24: 707-10(May 1969). (In Russian).

The method suggested for determining molybdenum is based on the molybdenum(VI) extraction from acid media with a benzene solution of mono-2-ethylhexyl phosphate back-extraction with hydrogen peroxide, and photometric determination in the back-extract by a thiocyanate method. The method can be used for determining microgram amounts of molybdenum (1 to 200 μg) in solutions of different composition. (auth)

**28693** FLUORIMETRIC DETERMINATION OF CERIUM(III) BY MEANS OF SULPHONAPHTHOLAZORESORCINOL. Ch'an Ty H'eu; Volkova, A. I.; Get'man, T. E. (Inst. of General and Inorganic Chemistry, Kiev). Zh. Anal. Khim., 24: 688-92(May 1969). (In Russian).

Spectrophotometric and fluorescent characteristics of the cerium(III) compound with 4-[(2,4-dihydroxyphenyl)azo]-3-hydroxy-1-naphthalenesulfonic acid have been studied. The optimum pH value for the complex formation has been found. The solution fluorescence can be intensified by means of hexamethylenetetramine or ammonia acetate buffer solutions, or by adding organic solvents to aqueous solutions of the complex. The quantum yield of the complex fluorescence has been calculated; it has been shown that the sensitivity of cerium determination is the highest 75% acetone at pH 4.5 in the presence of a buffer solution. A fluorimetric method has been developed for determining cerium(III) in the presence of thorium. The sensitivity of the determination is 0.25 μg of cerium in 5 ml of solution. (auth)

**28694** ON THE INTERACTION OF SCANDIUM WITH 2,2',4'-TRIHYDROXYAZO COMPOUNDS. Antonovich, V. P.; Nazarenko, V. A. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim., 24: 676-81(May 1969). (In Russian).

The interaction of scandium with 2,2',4'-trihydroxyazobenzene, 5-chloro-2,2',4'-trihydroxyazobenzene, and 5-chloro-2,2',4'-trihydroxyazobenzene-3-sulfonic acid (lumogallion) has been studied spectrophotometrically. Scandium forms two complexes with each of the reagents studied at a ratio of Sc:R = 1:1 in a more acid medium and one complex at a ratio of Sc:R = 1:2 in a less acid medium. The complex forming cations for the 1:1 complexes are the $Sc^{3+}$ ions and for the 1:2 complex with lumogallion it is $ScOH^{2+}$. Trihydroxyazo compounds react with scandium in a p-quinonehydrazonic form. The ionization constants of 5-chloro 2,2',4'-trihydroxyazobenzene at $\mu = 0.1$ have been measured. It has been found that with lumogallion and antipyrine scandium forms a complex of Sc:R:Ant = 1:1:3 which is extracted by chloroform. The determination of scandium by the extraction-photometric method is possible within the interval of $1 \times 10^{-6}$ to $4 \times 10^{-5}$ g-ion/liter of scandium (auth)

**28695** PHOTOMETRIC AND EXTRACTION-PHOTOMETRIC METHODS FOR THE DETERMINATION OF SELENIUM AND TELLURIUM (A REVIEW). Murashova, V. I.; Sushkova, S. G. (Urals Polytechnical Inst., Sverdlovsk, USSR). Zh. Anal. Khim., 24: 729-42(May 1969). (In Russian).

A review of the literature on the photometric and extraction-photometric methods for the determination of selenium and tellurium is given. All the methods known can be classified into

four groups depending on the reactions that proceed during the formation of colored compounds: the formation of colored sols of selenium and tellurium; the formation of colored complex compounds of selenium and tellurium with organic and inorganic ligands; the oxidation of organic reagents by tetravalent ions of selenium and tellurium; and all the other methods. Colored complex compounds of selenium are formed by selenium(II). Complex compounds of tellurium(II) and tellurium(IV) are used for tellurium determination. (254 references.) (auth)

**28696** DETERMINATION OF CERTAIN RARE EARTH ELEMENTS AS IMPURITY IN YTTRIUM OXIDE BY A LUMINESCENT METHOD. Poluektov, N. S.; Vitkun, R. A.; Gava, S. A. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim., 24: 693-7(May 1969). (In Russian).

A luminescent method for determining Sm, Eu, Dy, Ho, Er, and Tm in yttrium oxide has been developed. The method is based on recording the luminescent spectra of yttrium vanadate obtained by treating the sample with $NH_4VO_3$. The sensitivity of the method is $(1.5 \div 8.2) \times 10^{-5}$%. (auth)

**28697** URANIUM(IV) TETRAMETAPHOSPHATE AS A NEW WEIGHT FORM FOR THE DETERMINATION OF URANIUM. Nemodruk, A. A.; Glukhova, L. P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 24: 794-7(May 1969). (In Russian).

Uranium(IV) tetrametaphosphate as formed by heating uranium compounds with phosphoric acid or ammonium phosphate at 900 to 1100°C in the air irrespective of the valence state of uranium in the initial compounds. Because the tetrametaphosphate of uranium(IV) $U(PO_3)_4$, is nonhygroscopic and chemically stable, it is recommended as a weight form for the gravimetric determination of uranium. (auth)

**28698** THE APPLICATION OF $SF_6$ FOR $\delta^{34}S$-DETERMINATIONS. Leskovsek, H.; Marsel, J.; Slivnik, J. (Institut Josef Stefan, Ljubljana, Yugoslavia). Isotopenpraxis, 5: 72-4(Feb. 1969). (In German).

A method for chemical preparation of $SF_6$ from mineral sulfides for $\delta^{34}S$ measurements is described. Samples of mineral sulfides are converted to $SF_6$ by fluorinating with elemental fluorine at 150°C and 5 atm. Chemical and physical properties of $SF_6$ allow relatively simple purification of the product. Furthermore, due to the higher mass range, low memory effect, and monoisotopic fluorine, the mass spectrometric measurements with $SF_6$ are simpler than measurements with $SO_2$. As an example, $\delta^{34}S$ values for some samples, obtained by using $SF_6$ and $SO_2$ are given. (auth)

**28699** INVESTIGATIONS OF AN IR SPECTROPHOTOMETRIC DETERMINATION OF $^{15}N$ AND $^{18}O$. Schmidt, H.-L.; Schmelz, E.; Rohns, G. (Univ. des Saarlandes, Saarbruecken, Ger.). Z. Anal. Chem., 243: 59-67(1968). (In German).

From Conference on Analytical Biochemistry, Munich, Germany. See CONF-680459.

$^{15}N$ or $^{18}O$ from organic compounds must be converted into substances suitable for infrared analysis via ammonia or water, respectively. $NH_3$ can be reacted quantitatively in the millimole scale with sulfochlorides or halonitrobenzenes; $H_2O$ adds quantitatively to carbodiimides or inamines. The shifts of some ir-absorption bands of the labeled reaction products are given. The dependence of the carbonyl adsorbancy of N,N'-di-p-tolylurea on the $^{18}O$ content is demonstrated. From the amplitude of the N–H-absorption in different spectra of $^{15}N$-2,4-dinitroaniline samples against $^{14}N$-2,4-dinitroaniline a calibration curve was obtained, which can be used for determining the $^{15}N$ content of test substances. The scope of the method is discussed. (auth)

**28700** SIMPLE DEVICE FOR EMISSION-SPECTROSCOPIC $^{15}N$ DETERMINATION IN MICRO-QUANTITIES. Seiler, Nikolaus; Werner, Gottfried (Max-Planck-Institut fuer Hirnforschung, Frankfurt am Main). Z. Anal. Chem., 243: 169-73 (1968). (In German).

From Conference on Analytical Biochemistry, Munich, Germany. See CONF-680459.

A simple device for emission-spectroscopic $^{15}N$ determination with photoelectric recording is described. The nitrogen is stimulated for light emission in glass tubes between capacitor plates of an oscillator circuit. The frequency is regulated to 13.9 MHz by means of a high frequency generator (DX-60, Heathkit) with an effective power of 15 to 20 W. The dispersion and detection of the emitted light is performed by a Zeiss Spectrophotometer PMQ II, used with a wave-length scanner and a recorder. (auth)

**28701** X-RAY FLUORESCENCE ANALYSIS OF URANIUM IN POWDERED SAMPLES WITH SHORT WAVELENGTH SPECTROMETER FRS-2. Lenin, S. S.; Serikov, I. V.; Sokolov, M. M. At. Energ. (USSR), 25: 531-2(Dec. 1968). (In Russian).

X-ray spectral analyses were used for determination of uranium in powdered specimens. The results of tests with several hundred specimens, separated into five groups according to their uranium content, are tabulated. The analysis of specially prepared specimens revealed that the presence of up to 10% Br, Zr, and Mo and up to 1 to 2% Y, Pb, and Th does not interfere with uranium determination. The interfering elements in this method of analysis were Sr and Rb. (R.V.J.)

**28702** BACK TITRATION WITH MERCURIC NITRATE IN UROTROPINE BUFFERED MEDIA, DETERMINATION OF SMALL AMOUNTS OF TITANIUM AND ZIRCONIUM. ANALYSIS OF BINARY AND TERNARY MIXTURES. Khalifa, H.; Ismail, I. A. (Ministry of Industry, Cairo). Microchem. J., 14: 12-21(Mar. 1969).

Simple reliable methods for determining small amounts of Ti and Zr applying back titration of excess EDTA with mercury(II) and the silver amalgam electrode are given. Using this method with additional volumetric or gravimetric methods, binary and ternary mixtures are successfully analyzed. In all cases potential breaks of quite large order of magnitude lying in the immediate vicinity of the theoretical end points are obtained. With or without slight modifications, the present methods can be applied to the analysis of alloys and related materials such as ilmenite, ferrotitanium, and zircon. (auth)

**28703** RAPID METHOD FOR DETERMINATION OF MICRO-QUANTITIES OF CERIUM. Bogovina, V. I.; Usatenko, Yu. I.; Mal'tsev, V. F. (Dnepropetrovsk Chemical-Technological Inst., USSR). Zavod. Lab., 35: 260-5(1969). (In Russian).

The proposed method consists of oxidation of Ce(III) by potassium permanganate and by Mn(III) in strong sulfate solutions without the addition of complex-forming substances. The methods for straight-line amperometric determinations of Ce and for successive amperometric titrations of Ce and V in cast irons, steels, and alloys of iron, nickel, chromium, and aluminum were developed. A rapid method for photometric determination of cerium was also worked out. Ce(III) is separated in the form of the fluoride, oxidized by potassium permanganate in a sulfate solution, and photometrically determined using o-toluidine. (tr-auth)

**28704** EXTRACTION-COMPLEXOMETRIC DETERMINATION OF LANTHANUM IN THE PRFSENCE OF ALUMINUM. Ivanova, Zh. M.; Shevchuk, I. A. (Donetsk State Univ., USSR). Zavod. Lab., 35: 272-4(1969). (In Russian).

A method was worked out for determination of lanthanum in the presence of aluminum by extraction of sulfate complexes of lanthanum using chloroform solutions of dodecylamine. The accuracy of the determination is from 1.4 to 2.5%. The determination of lanthanum is possible at La : Al ratios of 1 : 25. In necessary cases repeated extractions may be used. (tr-auth)

**28705** THIN-LAYER CHROMATOGRAPHY IN DISPOSABLE PLASTIC BAGS FOR RADIOACTIVE AND NON-RADIOACTIVE SUBSTANCES. Gupta, Gopi Nath (Rockefeller Univ., New York). J. Chromatogr., 41: 467-70(May 20, 1969).

The use of inert, transparent, resistant to most organic solvents, mylar-type polyester plastic bags with thin-layer chromatography is described. A wide variety of rectangular and sandwich-type glass chambers used for TLC can be easily substituted by these plastic bags. The plastic bag can accommodate all types, sizes, and shapes of glass plate or sheet for TLC with the use of a plate or sheet holder of appropriate dimension. TLC in a disposable plastic bag is simple, convenient, and versatile. Methods using the sandwich-type and rectangular-type developing chambers are described. (P.C.H.)

**28706** OSCILLOPOLAROGRAPHIC DETERMINATION OF THE PLATINUM METALS. Woodburn, S. I.; Magee, R. J. (La Trobe Univ., Victoria, Australia). Microchem. J., 14: 102-9(Mar. 1969).

Palladium and rhodium can be determined in the presence of platinum, ruthenium, and iridium using 2-methylpyridine. Osmium blocks out the wave due to rhodium. Rhodium and osmium can, however, be determined in the presence of palladium using 4-methylpyridine. (auth)

**28707** INTERFEROMETRIC DETERMINATION OF SMALL AMOUNTS OF $D_2O$ AND $H_2O$. Mercea, Judith (Institut fuer Atomphysik, Cluj). Chem.-Ing.-Tech., 41: 508-10(Apr. 1969). (In German).

The small amounts of $D_2O$ and $H_2O$ that can be detected by this method suggest that the process can be applied successfully to the investigation of isotope transfer at phase boundaries and in systems in which the equilibrium distribution has not yet been reached. (auth)

**28708** A METHOD FOR SPECTROSCOPICALLY ANALYZING A SAMPLE BY DETECTING A RADIATION FIELD CHANGE AS A FUNCTION OF THE RADIATION POWER DENSITY IN THE SAMPLE. Bauhaus, Richard H.; Harrington, Howard W.; Poulter, Howard C. (to Hewlett-Packard Co.). U. S. Patent 3,440,529, Apr. 22, 1969. Filed Feb. 21, 1966.

Electromagnetic radiation was applied to a sample of matter to produce a spectroscopic transition that causes a change in each field component of the applied electromagnetic radiation. The change in each field component is varied by varying the power density of the electromagnetic radiation applied to the sample. Variations in the change of a selected field component are detected as a function of the variations in power density under power saturated conditions to determine the maximum change of the selected field component. (Offic. Gaz.)

**28709** DETERMINATION OF FREE ACIDS IN PLUTONIUM, URANIUM, AND THORIUM SOLUTIONS. Schmieder, Helmut; Kuhn, Erwin (Kernforschung mbH, Karlsruhe, Ger.). Talanta, 16: 691-700(June 1969). (In German).

Since the actinides easily undergo hydrolysis, titration is performed in a non-aqueous system (2-propanol). Plutonium, uranium and thorium are precipitated as double salts by the addition of cesium chloride. Sodium ethoxide is used as titrant, with phenolphthalein serving as a visual indicator. A photometric titrator was also tested. (auth) (UK)

**28710** PROGRESS IN ANALYTIC METHODS FOR THE ION MICROPROBE MASS ANALYZER. Andersen, C. A. (Hasler Research Center, Goleta, Calif.). J. Mass Spectrom. Ion Phys., 2: 61-74(Jan. 1969).

The ion microprobe mass analyzer accomplishes the chemical analysis of a microvolume of a solid sample by sputtering ions from its surface with a high-energy beam of bombarding ions. The relative sputtered ion yields of many different elements and compounds were studied as a function of the chemical species of the bombarding beam. It was observed that when the bombarding beam is composed of an inert gas the positive sputtered ion yield of metals typically decays with time of bombardment. The sputtered ion yield can be maintained at a high stable level by bombarding with one of the reactive, electronegative gases. It was also observed that the sputtered ion yield is simply and reproducibly related to the sputtered atom yield when bombarding with reactive gases. (auth)

**28711** ABSOLUTE ISOTOPE RATIO DETERMINATION OF A NATURAL BORON STANDARD. De Bievre, P. J.; Debus, G. H. (EURATOM, Geel, Belgium). J. Mass Spectrom. Ion. Phys., 2: 15-23(Jan. 1969).

An absolute value for the isotope ratio of a natural boron stock was determined by thermal-ionization mass spectrometry of borax, using isotopic blends prepared from enriched $^{10}B$ and $^{11}B$ covering a $^{10}B$ concentration range between 10 and 90%. The $^{10}B/^{11}B$ atom ratio of the natural boron stock is 0.24726 ± 0.00032, which corresponds to a $^{10}B$ atom concentration of 19.824 ± 0.020 (0.1%) and an atomic weight of 10.81178 ± 0.00020. Uncertainties are based on 95% confidence limits for the mean and estimates of maximum possible systematic errors. (auth)

**28712** COLORIMETRIC DETERMINATION OF ZIRCONIUM WITH 1-(2-PYRIDYLAZO)-2-NAPHTHOL. Ross, L. E.; Drabek, V. M.; Larsen, R. P. (Argonne National Lab., Ill.). Talanta, 16: 748-50(June 1969).

A method is described for the determination of as little as 50 ppM of zirconium in uranium-fission element alloys and zinc–magnesium–uranium-fission element alloys. Zirconium is extracted from a nitric acid–aluminium nitrate medium with dibutyl phosphate in toluene. The uranium co-extracted with the zirconium is removed by scrubbing with hydrochloric acid–ammonium thiocyanate solution. A portion of the organic phase is mixed with a pyridine–toluene solution of 1-(2-pyridylazo)-2-naphthol to develop the colour. (auth) (UK)

**28713** ELECTRON MICROSCOPY AND MICROANALYSIS OF METALS. Belk, J. A.; Davies, A. L. (eds.). New York, American Elsevier Publishing Company, Inc., 1968. 260p. $17.50.

The principles of electron optics are outlined in detail. Chapters on the following topics pertaining to electron microscopy are included: electron diffraction; specimen preparation; use of replicas in materials investigations; deformation studies; precipitation studies; and dark field microscopy and strain measurements. The following aspects of microanalysis are discussed: design of microanalysers; analysis techniques; quantitative analysis; and industrial applications. (134 references). (J.G.B.)

## Isotopic Procedures

**28714** SIMULTANEOUS DETERMINATION OF TRACE ELEMENTS IN PLATINUM BY ISOTOPE DILUTION AND SPARK SOURCE MASS SPECTROMETRY. Alvarez, Robert; Paulsen, Paul J.; Kelleher, Daniel E. (National Bureau of Standards, Washington, D. C.). Anal. Chem., 41: 955-8(June 1969).

An isotope dilution technique using the spark source mass spectrograph was investigated for applicability to simultaneous multielement trace determinations. Isotopically altered Ag, Cu, Ni, Pb, and Pd were separated from a 250-mg sample of platinum by cation exchange, and electrodeposited onto gold electrodes for sparking in the spectrograph. Electrodeposition provided the spiked analytes in an adherent form, relatively free of anions and organic residue from the ion exchange resins, both of which could complicate the spectrum. Contamination, the principal limitation of the method, was minimized by isothermally distilling the reagent acids and by isolating the operations from the laboratory environment. After determining the isotope ratios, the concentrations were computed, ranging from 0.5 ppM (μg/gram) for Ni to 14 ppM for Pb. Improved precision and accuracy were obtained compared to conventional spark source analysis. The results were compared with those of other methods and the platinum material was issued by NBS as Standard Reference Material 681. (auth)

**28715** ADVANTAGES OF A TWO-DETECTOR SYSTEM IN AUTOMATED SUBSTOICHIOMETRIC RADIOISOTOPE DILUTION ANALYSIS. Lamm, C. G.; Ruzicka, J. (Technical Univ. of Denmark, Lyngby). Talanta, 16: 603-11(May 1969).

Automation widens the scope of substoichiometric radioisotope dilution analysis. This is because the very strict requirement of the manual method–chemical separation of exactly equal quantities of the test substance—need no longer be fulfilled: reproducibility of the determination is reached by means of automated operation and activity measurement. The theory given shows how the choice of suitable chemical reactions is widened and why the reliability and the advantages of isotope dilution analysis are improved by the use of a two-detector system. (auth) (UK)

**28716** DETERMINATION OF ELEMENTARY SULFUR BY MEANS OF ISOTOPE DILUTION METHOD. Hasegawa, Keishi; Onodera, Takashi (Toa Nenryo Kogyo K. K., Tokyo). Nenryo Kyokai-shi, 48: 171-5(Mar. 1969). (In Japanese).

Using the Kattwinkel method employing isotope dilution, elementary S was determined in prepared samples containing 1 mg or more of S with an accuracy of ±10%. Elementary S was determined in light distillates and fuel products. The S content of kerosene, gas oil, and heavy naphtha was found to be 0.38 to 0.44 mg/100 ml, 1.1 to 1.5 mg/100 ml, and 3.9 to 4.4 mg/100 ml, respectively. (NSA of Japan)

## Radiometric Procedures

*Refer also to abstracts 29957, 29958, 30302, and 31235.*

**28717** (BNWL–1005) NONDESTRUCTIVE ANALYSIS OF FUEL IRRADIATED IN THE EBWR BY GAMMA SCANNING. Murphy, E. S.; Manca, G.; Christensen, D. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1969. Contract AT(45-1)-1830. 87p. Dep. CFSTI.

As a part of the Plutonium Recycle Demonstration experiment conducted in the Experimental Boiling Water Reactor with plutonium enriched fuel, several intact fuel elements and a number of fuel rods were analyzed by counting the fission product gamma rays emitted by the fuel. This nondestructive method provided valuable data about the performance of the plutonium enriched fuel as a function of exposure. A large part of the data is relative count rates, taken with a NaI(Tl) detector and presented to indicate: the relative power generation profiles of $UO_2$–1.5 wt% $PuO_2$, Al–3.35 wt% $PuO_2$, and natural $UO_2$ fuel rods at varying exposures; the relative power generation profile of a fuel element as well as the profile of the plutonium enriched region of the core as a function of exposure; changes to power generation profiles and how the changes correlate to reactor operating history, i.e., power level changes and control rod movements; core symmetry; performance characteristics of different nuclear fuels irradiated in the same environment with the same power history; and the contribution to the total gamma activity measured outside an intact fuel element from each rod in a six rod column inside the element. Gamma energy spectra data were also obtained with a Ge(Li) detector for the different fuels that were part of the irradiation experiment and several spectra are presented. However, the spectrum analysis is not complete and absolute results are not presented. (auth)

**28718** (GA-8588) POSTIRRADIATION CHEMICAL EXAMINATION OF THE GAIL IV FUEL ELEMENT. Bell, W. E.; Anderson, E. E.; Milstead, C. E. (Gulf General Atomic, Inc., San Diego, Calif.). June 24, 1968. Contract AT(04-3)-167. 70p. Dep. CFSTI.

The postirradiation chemical examination of the GAIL IV fuel element is described with respect to metallic fission product concentrations found throughout the graphite. The fuel element consisted of a 12-hole, "telephone-dial" cross-sectional configuration with loose, Triplex pyrolytic-carbon-coated $(Th,U)C_2$ fuel particles packed into the holes. It was scanned to determine gamma activity as a function of distance along the element. Thirty-one corings were taken at various locations in the graphite body after the fuel particles and spines were removed. Gamma spectra of samples from the corings were recorded and analyzed using a computer program. Tables list concentrations of the various nuclides in the graphite between the fuel and the coolant and between the spine and the fuel. Data are included for $^{90}Sr$, $^{89}Sr$, $^{103}Ru$, $^{106}Ru$, $^{137}Cs$, $^{140}Ba$, $^{141}Ce$, $^{144}Ce$, $^{154}Eu$, $^{155}Eu$, $^{46}Sc$, $^{54}Mn$, $^{60}Co$, $^{110m}Ag$, $^{134}Cs$, and $^{182}Ta$. (M.C.G.)

**28719** (GA-9331) APPLICATION OF PHOTOINDUCED REACTIONS TO NUCLEAR MATERIALS SAFEGUARDS PROBLEMS. Quarterly Progress Report, January 1-March 31, 1969. Brambiett, R. L.; Gozani, T.; Ginaven, R. O.; Kull, L. A.; McMillan, J. I.; Rundquist, D. E. (Gulf General Atomic, Inc., San Diego, Calif.). Apr. 21, 1969. Contract AT(04-3)-167. 28p. Dep. CFSTI.

Using a CDC 1700 on-line computer, fission product gamma data were taken as a function of time after irradiation with bremsstrahlung. These gamma spectra will be used to identify fission products. A simple and sufficiently intense source of subthreshold neutrons can be obtained from the $(\gamma,D)$ reaction on $D_2O$. These neutrons were used to determine $^{235}U$ and $^{238}U$ in samples. Uranium oxide samples were analyzed for $^{235}U$ by a passive scan method. The prompt detection of neutrons produced by an electron linear accelerator is hampered by the strong gamma flash that paralyzes the neutron counting system for some time following the beam pulse. A reduction in this effect was successfully attempted with a small fission chamber and a bank of large $BF_3$ counters. The method is based on the removal of coherent signals. The FITT code was developed to meet the requirements of nuclear materials assays. The performances of an accelerator section and injector for the Prototype Assay LINAC (PAL) were calculated. (M.C.G.)

**28720** (MLM-1585) GAMMA-RAY ASSAY OF $^{238}Pu$ IN WASTE CANS. PART I. SINGLE-CHANNEL ASSAY. PART II. MULTICHANNEL ASSAY. Strohm, W. W.; Combs, A. B.; Jarvis, J. Y. (Mound Lab., Miamisburg, Ohio). May 12, 1969. Contract AT(33-1)-Gen-53. 39p. Dep. CFSTI.

Two techniques are described for assaying the amount of $^{238}Pu$ in cans of contaminated waste by measuring the intensity of the 765-keV gamma ray from the decay of $^{238}Pu$ with a NaI(Tl) detector. In both techniques, the transmission T of the 765-keV gamma ray through the waste material in the can is determined from the weight w of the can. The determination of $T(w) = 1.04e^{-0.000212w}$ and its very small dependence on the material in the can is described. The first technique is a single-channel analysis of the 765-keV photoelectric peak developed for an in-line assay. For these measurements, one standard deviation is +59% and −14%. The second technique utilizes a multichannel analyzer, and contributions of higher-energy gamma rays to the 765-keV photoelectric peak are subtracted. The accuracy of this technique is ±15% at the 95% confidence level when the can contains 0.100 g or more of $^{238}Pu$. (auth)

**28721** (MLM-1621) ELECTRODEPOSITION OF PLUTONIUM FOR ALPHA PULSE HEIGHT ANALYSIS OF $^{236}Pu$ IN $^{238}Pu$. Amos, W. R.; Lambek, R. H. (Mound Lab., Miamisburg, Ohio). May 9, 1969. Contract AT(33-1)-Gen-53. 7p. Dep. CFSTI.

An apparatus was constructed and a method was developed for the electrodeposition of nanogram quantities of plutonium onto a stainless steel slide. The deposit was thin, uniform, and alpha-wipe free, and the plutonium was quantitatively transferred from the plating solution. Because of the characteristics of the deposit, accurate alpha pulse height analysis of small quantities of $^{236}Pu$ in $^{238}Pu$ was possible. (auth)

**28722** USE OF RADIOACTIVE KRYPTONATE OF THALLIUM IN THE DETERMINATION OF OXYGEN DISSOLVED IN WATER OR OTHER LIQUIDS. Toelgyessay, J.; Varga, S. (Slovak Technical Univ., Bratislava). Talanta, 16: 625-6(May 1969).

Radioactive kryptonate of thallium is placed in the liquid sample. Oxygen dissolved in the sample reacts with the surface layer of radioactive kryptonate and releases radioactive krypton in an amount proportional to the amount of oxygen. (auth) (UK)

**28723** DETERMINATION OF $^{226}Ra$ AND $^{228}Th$ IN FOOD, SOIL, AND BIOLOGICAL ASH BY MULTIDIMENSIONAL COINCIDENT GAMMA-RAY SPECTROMETRY. Sanderson, Colin G. (Atomic Energy Commission, New York). Health Phys., 16: 747-53(June 1969).

A multidimensional coincident gamma spectrometer was used for the direct determination of extremely low levels of coincident gamma emitting radionuclides in environmental samples. Both qualitative and quantitative analyses can be made with this spectrometer, which detects individual radionuclides that decay with the emission of cascading gamma rays. The sample is mounted between two primary 20 cm × 10 cm NaI(Tl) crystals, which are enclosed in a large cylindrical plastic phosphor anticoincidence shield. Only those events which occur in coincidence and are detected by the two primary crystals are recorded in the 4096 channel analyzer. This combination of coincident counting and anticoincident shielding reduces background by a factor of about 200. The application of this spectrometer to the determination of $^{226}Ra$ in various environmental media has given quantitative measurements which agree within 15% of those obtained by radiochemical methods. The calculated $^{228}Th$ in these samples agrees with radiochemical values for environmental samples reported by the UNSCEAR. (auth) (UK)

**28724** IMPROVED PROCEDURE FOR SOLID SCINTILLATION FLUOROGRAPHY OF TRITIUM LABELED COMPOUNDS. Randerath, Kurt (Harvard Univ., Boston). Anal. Chem., 41: 991-2(June 1969).

A new and simple procedure for solid scintillation fluorography of $^3H$-labeled compounds is described. Its sensitivity is 0.006 to 0.008 $\mu Ci/cm^2/day$. On one-dimensional thin-layer chromatograms (spot area 0.3 $cm^2$) 0.002 to 0.003 $\mu Ci$ $^3H$ can be clearly visualized after exposure for 24 hr. Various factors affect the sensitivity. In the case of $^{14}C$-labeled compounds the fluorographic procedure was found to be of approximately the same sensitivity as autoradiography (lower limit of detection 0.0005 $\mu Ci/cm^2/day$). (P.C.H.)

**28725** DETERMINATION OF ELEMENTS BY NUCLEAR REACTIONS AT LOW ENERGY. Deconninck, G. (Univ., Louvain, Belgium). Ann. Soc. Sci. Brux. Ser. I, 83: 45-64 (Apr. 25, 1969). (In French).

The methods of sample analysis by detection of prompt emission in low energy nuclear reactions are described. The nuclear reactions are classified with respect to the nature of emitted particle and to the weight of the target nucleus. A classification of the nuclear reactions to be utilized in various cases is also reported. (auth)

**28726** DETERMINATION OF SMALL AMOUNTS OF TBP AND DBP IN URANYL NITRATE SOLUTIONS. Ishimori, Tomitaro; Ueno, Kaoru (Japan Atomic Energy Research Inst., Tokai). Talanta, 16: 613-16(May 1969).

Tributyl and dibutyl phosphates (TBP and DBP) in concentrated uranyl nitrite solution are determined by a method based on the solvent extraction of $^{95}Zr$. The distribution ratio of $^{95}Zr$ between dilute solutions of TBP and DBP in dodecane and 10M hydrochloric acid and 1M nitric acid, respectively, is measured. There is a logarithmic relationship between the distribution ratio and concentration of TBP and DBP, which enables them to be determined rapidly and with an error of ±10% over the range 1 to 100 ppM of TBP and 40 to 600 ppM of DBP. The lower limit is 0.5 ppM for TBP and 10 ppM for DBP. (auth) (UK)

**28727** IMMUNOPRECIPITATION ON CHROMATOGRAPHY PAPER DISKS FOR THE DETERMINATION OF MONO- AND DOUBLE-LABELLED SPECIFIC PROTEINS. Schreiber, G.; Rotermund, H.-M.; Dimigen, E.; Maeno, H. (Univ., Freiburg i. B.). Z. Anal. Chem., 243: 173-83(1968).

From Conference on Analytical Biochemistry, Munich, Germany. See CONF-680459.

From a mixture of labeled proteins specific proteins can be isolated by immunological precipitation on chromatography paper disks and their radioactivity can be determined in liquid scintillation counting systems. Precipitation is completed within 2 hours. Analysis of double labeled proteins can also be performed on disks of chromatography paper. The counting efficiency for [$^{14}C$] protein disks is 60%, for [$^3H$] protein disks 8%. The statistical variation of the method is lower than 5%. Quenching, unspecific adsorption of aromatic amino acids, and immunological cross reactions are discussed. The method is especially useful when many samples are to be processed simultaneously. (auth)

**28728** NEW METHODS FOR THE ANALYSIS OF RADIOACTIVE AND STABLE ISOTOPES OF HYDROGEN, CARBON, NITROGEN, AND OXYGEN. Simon, H.; Guenther, H.; Kellner,

M.; Tykva, R.; Berthold, F.; Kolbe, W. (Technische Hochschule, Munich). Z. Anal. Chem., 243: 148-69(1968). (In German).

From Conference on Analytical Biochemistry, Munich, Germany. See CONF-680459.

Measuring tritium in gas counting tubes filled with propane and using a single channel discriminator with great dynamic range yields a considerably lower background, without diminishing the counting yield. If, in addition, an anticoincidence shield is used, a 150 ml counting tube shows about 1 cpm background. The figure of merit goes up to about 2500. An exact coordination between particle energy and impulse size is reached by the 60 keV $\gamma$ radiation of americium-241, without an influence of the relative geometry of the counting tube and the radiation source. By this procedure it is also possible to measure separately and simultaneously T and $^{14}C$ in one counting tube. The method is experimentally compared with liquid scintillation counting. A simple procedure is described for preparing samples for the determination of $^{18}O$- and D-labeled compounds. The applicability is shown by numerous mass spectrometric analyses. For determining $^{18}O$, with a few exceptions, the labeled compounds are pyrolized in sealed ampoules without any chemicals. Even stearyl alcohol delivers enough carbon dioxide. By this technique a rather uniform procedure is given for preparing samples in order to measure compounds labeled with D, T, $^{13}C$, $^{14}C$, $^{15}N$, and $^{18}O$. Experimental details are presented. (auth)

**28729** QUANTITATIVE DETERMINATION OF DEOXYRIBONUCLEOSIDE TRIPHOSPHATES IN ASCITES TUMOR CELLS BY USING $^{32}P$. Liss, E.; Schmidt, H.; Nowak, P. (Freie Univ., Berlin). Z. Anal. Chem., 243: 142-8(1968). (In German).

From Conference on Analytical Biochemistry, Munich, Germany. See CONF-680459.

The acid soluble compounds of ascites tumor cells after incubation with $^{32}P$-orthophosphate were separated by thin-layer chromatography. By using unlabeled deoxyribonucleoside triphosphates it was possible to localize the corresponding radioactive spots. From the radioactivity of the spots and the specific activity of the intercellular orthophosphate the amounts of the deoxyribonucleoside triphosphates could be calculated. (auth)

**28730** METHOD FOR THE DETERMINATION OF THE SPECIFIC RADIOACTIVITY OF "FREE AMINO-ACIDS" IN TISSUE EXTRACTS OF MAMMALS. Moeller, Hartwig; Seiler, Nikolaus; Werner, Gottfried (Max-Planck-Institut fuer Hirnforschung, Frankfurt am Main). Z. Anal. Chem., 243: 126-9(1968). (In German).

From Conference on Analytical Biochemistry, Munich, Germany. See CONF-680459.

Some experiments with a measuring device for the determination of the specific radioactivity of $^{14}C$-labeled brain amino-acids are described. The apparatus consists of an automatic amino acid analyzer combined with a flow cell filled with anthracene. The reproducibility of the method is ±5% to ±1% mequiv in the range of $1 \times 10^{-3}$ $\mu$Ci to $5 \times 10^{-2}$ $\mu$Ci. A quantative determination of $3 \times 10^{-4}$ $\mu$Ci/ml eluant is still possible. (auth)

**28731** RADIO-GAS-CHROMATOGRAPHIC ANALYSIS OF FATTY ACID METHYL ESTERS AND STEROIDS. Kolb, B.; Wiedeking, E. (Bodenseewerk Perkin-Elmer and Co. GmbH, Ueberlingen, Ger.). Z. Anal. Chem., 243: 129-42(1968). (In German).

From Conference on Analytical Biochemistry, Munich, Germany. See CONF-680459.

A description is given of comparative investigations in radio-gas-chromatography with a proportional flow-through counter tube after cracking either by hydrogenation or by oxidation of $^{14}C$- and $^{3}H$-labeled substances previously separated by gas chromatography. When hydrogenation was used, counting yields of 100% were found for both the $^{14}C$- and the $^{3}H$-labeled compounds. The determination of specific activities of $^{14}C$-labeled fatty acid methyl esters showed good agreement of the results obtained by hydrogenation and by oxidation. Some examples are given for analysis of $^{3}H$-labeled steroids after hydrogenation and of $^{14}C$-labeled steroids after oxidation. In addition, the application possibilities of support-coated open tubular columns in radio-gas chromatography are discussed. (auth)

**28732** COMBUSTION AND LIQUID SCINTILLATION DETERMINATION OF $^{14}C$ IN BIOLOGICAL SAMPLES. Smith, L. W. (Dept. of Agriculture, Beltsville, Md.). Anal. Biochem., 29: 223-9(May 1969).

A method for determination of $^{14}C$ in biological samples by combustion and subsequent liquid scintillation countings is described. Fifteen $^{14}C$ analyses can be performed in an hour with this procedure. The use of scintillation-vial absorption vessels allows the total activity of the sample to be counted, eliminating the need for close control of sample size, aliquoting, and/or transferring. Replicate samples can be determined within ±4% of the mean. (auth)

**28733** USE OF TWO RADIOISOTOPE SOURCES IN X-RAY FLUORESCENCE ANALYSIS OF MINERAL PRODUCTS. Bol'shakov, A. Yu. At. Energ. (USSR), 25: 535-6(Dec. 1968). (In Russian).

An x-ray fluorescence method is described in which two radioisotope sources with radiation energies $E_1$ and $E_2$, which are almost identical except that the magnitude $E_1$ is smaller than the K-radiation excitation energy ($E_1 < E_k$) and $E_2 > E_k$, are recorded simultaneously. Specimens of Hg and Pb with two sources $^{204}Tl$ and $^{75}Se$ are used in the determination. (R.V.J.)

**28734** DETERMINATION OF THE ACTIVITY OF $^{64}Cu$ IN REACTOR WATER. Schroeder, H. J.; Durcak, H. (Kernkraftwerk RWE-Bayernwerk GmbH, Gundremmingen, Ger.). Kerntechnik, 11: 144-5(Mar. 1969). (In German and English).

It is important to know the Cu concentration in the reactor water of a nuclear power station because of the buildup of Cu-containing deposits on fuel elements and internals. This Cu concentration is about $20 \times 10^{-6}$ g/l at full power steady state conditions in a large boiling water reactor. The specific activity of Cu due to $^{64}Cu$ is about 1 Ci/g. A method for controlling this activity on a routine base was developed. (auth)

**28735** THE DETERMINATION OF RADIUM AND THORIUM X IN LAYERS OF BARIUM SULFATE. Andreev, A. G.; Zherekhov, V. G.; Kutsenko, N. V. Radiokhimiya, 11: 80-4(1969). (In Russian).

A method is proposed for determination of radium and thorium X by measurement of the alpha activity of precipitates of barium sulfate. The sensitivity and accuracy of the method are discussed. (tr-auth)

**28736** A REVIEW OF INSTRUMENTATION AND PROCEDURES FOR $^{14}C$ AND $^{3}H$ RADIOASSAY BY THIN-LAYER AND GAS–LIQUID CHROMATOGRAPHY. Snyder, Fred L. (Oak Ridge Associated Univ., Tenn.). Isotop. Radiat. Technol., 6: 381-400(Summer 1969).

This review of instrumentation and procedures for radioassay by thin layer and gas–liquid chromatography deals with basic techniques, equipment, typical results, and the advantages or disadvantages of each procedure. The thin-layer chromatographic techniques discussed are elution analysis, strip scanning, autoradiography, zone analysis, beta-camera detection, and combustion analysis. Radiometric procedures for gas liquid chromatography include those using continuous-flow systems and those using collection systems that involve combustion and noncombustion techniques. (auth)

**28737** GAMMA SCANNING DATA FOR THE UNIRRADIATED FLAT FUEL PLATES OF UTR. Kiki, Ryota; Kondo, Yoshihide (Kinki Univ., Osaka). Kinki Daigaku Genshiryoku Kenkyusho Nenpo, No. 6, 55-68(1967). (In Japanese).

Nondestructive $\gamma$ scanning methods for determination of the uniformity of $^{235}U$ in highly enriched fuel plates was applied to plates of UTR, and the results are presented. (NSA of Japan)

**28738** METHOD OF DETECTING THE PRESENCE OF RADIOACTIVE SUBSTANCES IN A FLUID, AND APPARATUS FOR CARRYING OUT THIS METHOD. Callies, Dominique; Jaeger, Marcelle (to Commissariat a l'Energie Atomique). British Patent 1,150,107. Apr. 30, 1969. Priority date May 26, 1966, France.

A method and apparatus are described for detecting the presence of radioactive substances in the form of divided suspensions or solutions in fluids, particularly detection of U in the form of salts dissolved in water. The solution to be examined is passed through a detection space having a powder scintillator permanently in suspension within the space, and the photons emitted by the scintillator when it is activated by particles emitted by the radioactive substance in suspension or solution are detected. Mechanical agitation means or agitation of the fluid traversing the detection space keeps the scintillator in suspension. Zinc sulfide crystals with a particle size between 5 and 10 $\mu$ and activated with silver serve as scintillators. (B.L.M.)

**28739** DETERMINATION OF THE NATURAL RADIOACTIVITY IN LEAD. de Boeck, R. (Rijksuniversitetit, Ghent, Belg.). Meded. Vlaam. Chem. Ver., 30: 22-7(Jan.-Feb. 1968). (In Flemish).

The natural $^{210}Pb$ activity in Pb was determined through quantitative separation and subsequent measurement of the $^{210}Po$ daughter activity. The separation procedure for Po is based on cupferron and dithizone extractions and spontaneous deposition of the element on Ag foil. Counting and spectrometry of the $\alpha$ activity

were done with a ZnS (Ag) crystal and a silicon surface-barrier detector, respectively. Six different Pb samples were analyzed, ranging from very old Pb with a negligible $^{210}$Po content to recently manufactured lead containing up to 9100 disintegrations/hr/g Pb. It was also found that 2 cupferron ligands were bound in the Po-cupferron complex. (BBB)

**28740** DETERMINATION OF FISSION PRODUCTS BY A RADIOCHEMICAL PROCEDURE. Cornelis, Rita (Rijksuniversiteit, Ghent, Belg.). Meded. Vlaam. Chem. Ver., 30: 6-17 (Jan.-Feb. 1968). (In Flemish).

An analytical technique was developed to determine long-lived $\gamma$-emitting fission products of U. It consists of a sodium bisulfate melt of the fission product solution or the U fuel, followed by liquid-liquid extractions. Then the isotopes are counted with a standardized 3 × 3 in. NaI crystal. The total $\gamma$ spectrum of the original fission product solution, determined with a NaI crystal or a Ge-Li detector, is also analyzed mathematically by mixed $\gamma$ spectrometry. From a brief postirradiation of the fission product solution the concentrations of both $^{235}$U and $^{238}$U are determined. The absolute amount of fission products related to the U concentration allows the calculation of the percent atomic burnup, the irradiation time, cooling period, flux of the reactor, and original degree of enrichment of the U. (BBB)

**28741** DETECTION LIMIT FOR SILVER BY ENERGY-DISPERSION X-RAY ANALYSIS USING RADIOISOTOPES. Burkhalter, P. G. (Bureau of Mines, College Park, Md.). Int. J. Appl. Radiat. Isotop., 20: 353-62(May 1969).

The purpose of the study described was to determine the sensitivity for silver in silica using radioisotopic x-ray sources, electronic discrimination with a single-channel analyzer, and scintillation detectors. The sensitivity for silver was determined as a function of excitation energy. Using monoenergetic K-spectra x-ray sources of Sb, Te, and Ba, a normalized detection limit ranging from 21 to 13 ppM was obtained for 100-sec counting intervals. With an annular $^{125}$I source a detection limit of 15 ppM silver was measured. The effect on the detection limit of heavy metals common to silver ores was also investigated. A detection limit of 25 ppM or less was still obtained when 5% concentrations were present in the silica matrix provided x-ray interferences with the Ag K$\alpha$ radiation did not exist. The need for accurate background measurements for analysis in the parts-per-million range is emphasized. The sensitivities found indicate that a portable radioisotopic x-ray analyzer could be designed for low-grade silver ores. (auth) (UK)

**28742** ANALYSIS OF ATMOSPHERIC CONCENTRATIONS OF RaA, RaB, AND RaC BY ALPHA SPECTROSCOPY. Martz, Dowell E.; Holleman, Dan F.; McCurdy, David E.; Schiager, Keith J. (Colorado State Univ., Fort Collins). Health Phys., 17: 131-8(July 1969).

A new method is presented for determining the airborne concentrations of $^{218}$Po, $^{214}$Pb and $^{214}$Bi in atmospheres contaminated with $^{222}$Rn. The method employs alpha spectroscopy to measure the count rates of $^{218}$Po and $^{214}$Po present on a membrane filter sample at two post-sampling times. The individual air concentrations and the statistical variances associated with each may then be calculated from the equations given. Theoretical and experimental comparisons are presented which indicate the improved accuracy of the spectroscopic method over methods previously available. (auth) (UK)

## *Activation Procedures*

*Refer also to abstract 28957.*

**28743** (KURRI-TR-37) APPLICATION OF ACTIVATION ANALYSIS TO BIOLOGICAL SAMPLES. Shigematsu, Tsunenobu; Iwata, Shiro (Kyoto Univ. (Japan). Research Reactor Inst.). [nd]. 92p. (In Japanese). Dep.

Japan has lagged in the field of activation analysis partly because of the lack of facilities in the past. There is great need to train people in the application of activation analysis in medical and biological areas. A special committee on activation analysis was created by KURRI (Kyoto University Reactor Institute) in April 1966 to define problem areas and to provide researchers with pertinent information concerning the application of activation analysis to medicine and biology. The subjects covered include: preparation of biological samples for trace analysis by activation; pretreatment of biological materials; pretreatment procedures; sample collection and preparation; standards to be used in the activation analysis of biological materials; irradiation techniques; chemical separation techniques involved in the trace analysis of biological materials; quantitative analysis by gamma spectrometry; data processing for activation analysis; applications of activation analysis to medicine; sensitivity obtainable with the JRR-2 for activation analysis. (TTT)

**28744** (NYO-3624-3) TERRESTRIAL OCCURRENCE AND DISTRIBUTION OF $^{129}$I. Edwards, Raymond R. (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry). [1967]. Contract AT(30-1)-3624. 30p. Dep. CFSTI.

The occurrence of the long-lived $^{129}$I (half-life $1.6 \times 10^7$ years) in natural materials, expected from spontaneous and induced fission of uranium, and from cosmic-ray interaction with the atmosphere, meteorites, and similarly exposed materials, and the somewhat larger quantities introduced into the environment through atomic energy activities was explored. This was feasible because of the extreme sensitivity of activation analysis as a means of detection and assay of this nuclide. Development of the assay techniques, and their application to the study of iodine (in geochemistry, ecology, and geochronology) are discussed. Measurement of the $^{130}$I activation product in iodine obtained from Pleistocene (<13 My) brines and from Chilean caliche indicated a ratio of $^{129}I/^{127}I \geq 5 \times 10^{-12}$ for these geologically young materials, in essential agreement with hypothetical estimates. A sample of iodine from a much older (>300 My) brine gave the anticipated negative result. A large number of additional biological and mineral specimens were prepared for the activation analysis. (auth)

**28745** (THAI.-AEC-17) NEUTRON ACTIVATION ANALYSIS OF GOLD IN TEAK (TECTONA GRANDIS). (Office of Atomic Energy for Peace, Bangkok (Thailand)). 1968. 4p. Dep.

The amount of gold in teak was determined by using a neutron activation technique. The neutron flux utilized was of the order of $10^{10}$ n/cm$^2$/sec. The spectrum of the energy peak of gold was identified using a gamma-multichannel pulse height analyzer. The sensitivity for gold was approximately $10^{-7}$ g. In teak Na, As, Cu, Mn, and La were interfering elements in the energy region from 0.4 to 0.8 MeV. Nondestructive analysis was not possible and radiochemical separation was essential. The gold content of teak was 0.58 ± 0.0037 ppM. (auth)

**28746** (THAI.-AEC-22) DETERMINATION OF MANGANESE, COPPER, ZINC, IRON, AND MOLYBDENUM IN ANIMAL BLOOD SAMPLE BY NEUTRON ACTIVATION ANALYSIS. Chamnirokasarnt, Darakarnt (Office of Atomic Energy for Peace, Bangkok (Thailand)). 1969. 5p. Dep.

The technique of neutron activation analysis was applied to determination of Mn, Cu, Zn, Fe, and Mo in animal blood samples as supplied by IAEA for intercomparison purposes. One gram of the sample was found to contain 0.3786 ± 0.0019 $\mu$g Mn, 1.4146 ± 0.0025 $\mu$g Cu, 16.5713 ± 0.0607 $\mu$g Zn, 2.7025 ± 0.0446 mg Fe, and 0.0305 ± 0.0013 $\mu$g Mo. (auth)

**28747** NEUTRON ACTIVATION ANALYSIS OF ALMOST ANY OLD THING. Gordus, Adon A. (Univ. of Michigan, Ann Arbor). Contract AT(11-1)-912. Chemistry, 41: 8-15(May 1968). (COO-912-12).

The use of neutron activation analysis for determining elements in minerals, coins, and paint pigments is discussed. Results were of use in determining the source of obsidian used by the Hopewell Indians, the average silver content in medieval Islamic coins, and the authenticity of a painting. (D.H.M.)

**28748** INSTRUMENTAL ANALYSIS OF NEUTRON IRRADIATED SOILS. Kline, J. R.; Brar, S. S. (Argonne National Lab., Ill.). Soil Sci. Soc. Amer., Proc., 33: 234-8(Mar.-Apr. 1969).

Soils from a worldwide collection were analyzed by gamma spectrometry, after thermal neutron activation, to identify and measure trace elements in soils which can be studied by this technique, and to determine whether gamma spectra of soils can be used to identify specimens of soil and trace them to their geographical origin. Samples of 100-mg size were irradiated for either 5 or 10 min in the Argonne CP-5 reactor at a thermal neutron flux of $2 \times 10^{13}$ n/cm$^2$/sec. Gamma spectrometry of activated samples was delayed until 4 days after irradiation because of high levels of $^{24}$Na which obscured the longer-lived nuclides. Therefore, nuclides with half-lives shorter than 15 hours were not measured. Long-lived nuclides, which could be observed after 4 days of delay are $^{140}$La, $^{46}$Sc, $^{82}$Br, $^{59}$Fe, $^{51}$Cr, $^{60}$Co, $^{152}$Eu, $^{154}$Eu, $^{153}$Sm, $^{181}$Hf, and $^{95}$Zr-$^{95}$Nb. Quantitative determinations were easily made by nondestructive methods for La, Sc, Fe, Co, Eu, and Sm. Amounts of Sc were correlated with amounts of Fe, Co, and Eu in soils of highly diverse origin. Similar correlations were not obtained with La. Elemental relationships sometimes resulted in similar gamma spectra for soils of dissimilar origin. These spectra, therefore, raised doubts as to whether they could be used without other supporting evidence to identify soil specimens or trace them to their place of origin when the analysis is done with NaI crystals and 400-channel analyzers. (auth)

**28749** LANTHANUM AND SCANDIUM DISTRIBUTION IN THREE GLACIAL SOILS OF WESTERN WISCONSIN. Kline, J. R. (Argonne National Lab., Ill.); Foss, J. E.; Brar, S. S. Soil Sci. Soc. Amer., Proc., 33: 287-91(Mar.-Apr. 1969).

Neutron activation analysis was used to determine the total La and Sc content of three soils developed from loess-capped glacial till. The profiles were classified as Gray–Brown Podzolics (Hapludalfs) overlying paleosols developed in Rockain till. The total La content in the less than 250 $\mu$ fraction of these soils ranged from 18.1 to 37.1 ppM, with an average content of 23.7 ppM in the loess and 28.5 ppM in the glacial till. Total Sc in the soils ranged from 5.1 to 10.9 ppM with average contents of 6.5 and 9.0 ppM in the loess and glacial till, respectively. Translocation by pedogenic processes was indicated by the accumulation of these elements in the argillic B horizons. Correlation coefficients of La and Sc with clay percentages in the profiles were 0.79 and 0.88, respectively. (auth)

**28750** ULTRA-TRACE DETERMINATION OF OXYGEN AND CARBON BY CHARGED-PARTICLE ACTIVATION ANALYSIS. Rook, Harry L.; Schweikert, Emile A. (Texas A and M Univ., College Station). Anal. Chem., 41: 958-63(June 1969).

When considering ultra-trace analysis by charged particle activation using the equivalent thickness method of quantization, three factors are of prime importance to ensure valid results. First, accurate and well defined activation curves of the nuclear reactions being employed must be obtained. Second, all interfering reactions must be experimentally categorized to ensure the integrity of the radioisotope used for analysis. Third, all usable reactions for the analysis of a given element should be investigated to allow the best possible choice of reactions for analysis in a given matrix and impurity level. A study was made on the ultra-trace determination of oxygen and carbon by charged particle activation analysis following the above outlined procedure. Analytical results are given for the nondestructive determination of oxygen in silicon in the part-per-million to the part-per-billion range. Results of some selected samples were compared to results independently obtained by infrared spectrometry. (auth)

**28751** DETERMINATION OF INDIUM AND TIN BY ACTIVATION ANALYSIS USING REPLACEMENT SUBSTOICHIOMETRY. Obrusnik, Ivan (Inst. of Nuclear Research, Rez, Czech.). Talanta, 16: 563-6(May 1969).

A new method for the determination of indium by activation analysis was developed. It is based on the replacement of indium from indium dithizonate (in carbon tetrachloride) by a substoichiometric amount of aqueous mercury(II) solution. Preliminary steps are the extraction of indium from alkaline cyanide solution with an excess of dithizone solution and washing the extract with buffer solution. The time necessary for the separation is 10 to 20 min. With this method indium can be determined by using either short ($^{116m}$In, $t_{\frac{1}{2}}$ = 54 min) or long-lived radioisotopes ($^{114m}$In, $t_{\frac{1}{2}}$ = 50 d). As by the reaction $^{112}$Sn(n,$\gamma$)$^{113}$Sn (119d) $\rightleftarrows$ $^{113m}$In (104 min) indium-113m is formed, which has a different $\gamma$ spectrum from that of indium-114m, the determination of both indium and tin is possible. The proposed method was applied to the determination of indium and tin in granite and gallium. (auth) (UK)

**28752** DETERMINATION OF OXYGEN IN POLYETHYLENE BY FAST NEUTRON ACTIVATION ANALYSIS. Lisovskii, I. P.; Smakhtin, L. A. (Karpov Physico-Chemical Inst., Moscow). Zh. Anal. Khim., 24: 749-52(May 1969). (In Russian).

A laboratory setup for activation analysis based on the standard neutron generator NG-160 is described. An auxiliary device has been developed which permits the time of irradiation of the analyzed samples to be fixed. The possibility of rapid determining microamounts of oxygen in polymer materials is discussed. (auth)

**28753** DETERMINATION OF ZIRCONIUM IN HAFNIUM CONCENTRATES VIA THE NUCLEAR REACTION $^{90}$Zr (n,p)$^{90}$Y. Fischer, W. (Institut fuer Kraftwerke, Berlin). Isotopenpraxis, 5: 64-6(Feb. 1969). (In German).

A technique of determining zirconium traces in hafnium was developed based on the $^{90}$Zr(n,p)$^{90}$Y reaction, which is equivalent to the well-known $^{95}$Nb technique with respect to its sensitivity, but has some advantages as compared with that technique. Separation of $^{90}$Y from the target is quantitative and carrier-free when a combination of cation and anion exchange is used. Separation by extraction is also possible. (auth)

**28754** APPLICATION OF ACTIVATION ANALYSIS IN BIOCHEMISTRY. Lux, Franz (Technische Hochschule, Munich). Z. Anal. Chem., 243: 107-25(1968). (In German).

From Conference on Analytical Biochemistry, Munich, Germany. See CONF-680459.

The basic principles of activation analysis are discussed, and a survey of activation analysis in life sciences is presented. The special techniques needed for analysing biological material are outlined and using selected examples it is shown how various problems have been solved with activation analysis. The problems were classified as follows: determination of the main constituents (light elements C, N, O; other elements): derivative activation analysis; stable tracers, isotopic analysis; determination of trace elements; activation analysis in vivo. (88 references). (auth)

**28755** USE OF ACTIVATION ANALYSIS IN THE METAL AND STEEL INDUSTRIES. Nickel, H. (Kernforschungsanlage, Juelich, Ger.). pp 12-29 of Anwendungen der Neutronenaktivierung und Radioaktiver Indikatoren in der Grundstoffindustrie. Essen, Vulkan-Verlag Dr. W. Classen, 1967. (In German).

The possibilities for use of activation analysis in metal and steel industries are discussed. Neutron sources and particle accelerators are considered. Determinations of oxygen and carbon in metals and steels by activation techniques are described. (M.C.G.)

**28756** ARSINE DETERMINATION IN BIOLOGICAL MATERIAL BY ACTIVATION ANALYSIS. Thomas, Joergen; Kristensen, Lis Vinther (Danmarks Tekniske Hoejskole, Lyngby). Ugeskr. Laeger., 129: 553-5(Apr. 27, 1967). (In Danish).

Arsine can be determined quantitatively in biological samples by neutron irradiation in a reactor. During the irradiation $^{76}$As is formed which has a half-life of 26.5 hours and disintegrates with the emission of characteristic gamma radiation. Biological samples ranging in weight between 10 mg and 5 g were irradiated in quartz containers. Small samples of $As_2O_5$ also in quartz containers were irradiated together with the biological samples and served as standards. After irradiation, 20 to 30 mg of $As_2O_5$ were added to the samples as carriers. The samples were then completely oxidized in concentrated nitric acid, and the arsine was converted to $As_2O_5$ which then was dissolved in HCl. One ml of this solution was added to a filter paper. The radioactivity was determined in this sample by use of a thallium activated sodium iodate scintillator detector. The arsine content in blood of patients exposed to arsine were 0.45 to 1.41 $\mu$g per ml with a standard deviation of 0.02 $\mu$g per ml. The normal content in human blood was less than 0.02 $\mu$g per ml. (TTT)

**28757** APPLICATION OF ACTIVATION ANALYSIS FOR DETERMINATION OF OXYGEN IN STEEL. Stoll, Norbert; Wagner, Armand; Goedert, Louis. Stahl Eisen, 88: 775-82(July 11, 1968). (In French and German).

Equipment and techniques used for determination of oxygen in steel by neutron activation are described. (M.C.G.)

**28758** EVALUATION OF $\gamma$-SPECTRA WITH PROGRAMS. Freiburg, C.; Erdtmann, G.; Nuernberg, H. W. (Kernforschungsanlage, Juelich, Ger.). Z. Anal. Chem., 245: 95-103(1969). (In German).

Activation analysis requires the application of efficient data processing for the evaluation of the $\gamma$ spectra of samples containing several radionuclides, especially if preceding radiochemical separations are to be largely or completely eliminated. The essential aspects of two programs for quantitative determinations and qualitative identifications are described. These programs are based on the least squares analysis of the total spectrum and the search, arrangement and processing of the photopeaks. With respect to their details the programs are adapted for application on the computer IBM-360/75. (auth)

**28759** DETERMINATION OF ANTIMONY IN THE Bi–Sb ALLOY BY THE METHOD OF NEUTRON-ACTIVATION ANALYSIS. Karev, V. N.; Dolya, G. P.; Tutubalin, A. I.; Kovalenko, L. I. (Physical-Technical Inst., Kharkov). Zavod. Lab., 35: 297-8 (1969). (In Russian).

The amount of antimony in a monocrystalline Bi–Sb alloy was measured by the reaction $^{121}$Sb(n,2n)$^{120}$Sb at a neutron energy of 14.7 MeV and a flux of $1 \times 10^8$ neutrons/cm$^2$ · sec. Annihilation radiation was recorded by a gamma scintillation spectrometer. Quantitative determination of the amount of antimony present was carried out by comparison with the activity of a standard. The sensitivity of the method is $5 \times 10^{-6}$ g and the relative error of measurement does not exceed 3.4%. The data were compared with results of x-ray-spectral analyses. (tr-auth)

**28760** APPLICATION OF THE REACTION $^{11}$B(p,$\gamma$)$^{12}$C FOR DETERMINATION OF BORON. Vasil'ev, S. S.; Mikhailov, G. I.; Starchik, L. P.; Konanykin, L. V. (Inst. of Nuclear Physics, Moscow. Mining Inst., Moscow). Zavod. Lab., 35: 299-300(1969). (In Russian).

A method is proposed for determination of boron by the yields

from radiative capture of protons by the $^{11}B$ nucleus using an electrostatic generator. For the B–Si system the threshold of sensitivity is $2 \times 10^{-3}$ and $1 \times 10^{-2}$% on recording the intensity of the gamma with energies corresponding to ≥11 and ≥15 MeV. The time necessary for analysis is 5 min. (tr-auth)

**28761** APPLICATIONS OF NEUTRON ACTIVATION TO ON-STREAM ANALYSIS. Rhodes, J. R. (Texas Nuclear Corp., Austin). Isotop. Radiat. Technol., 6: 359-68(Summer 1969). (ORO-2980-17).

Neutron activation techniques for process analysis are reviewed. Some comments are made on applications of accelerator and radioisotope neutron sources and on detection of prompt or delayed gamma rays by spectrometric, coincidence, and anti-coincidence counting techniques. Different methods of sample presentation are surveyed, including semiautomatic batch sampling, conveyor-belt presentation of bulk materials, and continuous presentation of liquids and slurries. Applications include determination of oxygen in steel, nitrogen in food products, fluorine in fluoride minerals, aluminum in bauxite and cement, silicon in iron and a number of ores, and copper in copper ores. (auth)

**28762** THE SIMULTANEOUS DETERMINATION OF ZINC AND CADMIUM IN BIOLOGICAL MATERIALS BY NEUTRON ACTIVATION ANALYSIS. Chueca, Ana; Worwood, M.; Taylor, D. M. (Inst. of Cancer Research, Sutton, Eng.). Int. J. Appl. Radiat. Isotop., 20: 335-40(May 1969).

A method for the simultaneous determination of zinc and cadmium is described which is suitable for the analysis of small samples of biological material. Following neutron activation and a simple ion exchange separation zinc and cadmium are identified and assayed by gamma ray spectroscopy. The sensitivity of the method is about $3 \times 10^{-8}$ g for cadmium and about $2 \times 10^{-7}$ g for zinc. The method was applied to the determination of cadmium and zinc in subcellular fractions prepared from rat testes and kidney. Analysis of a standard kale powder yielded the values $32.8 \pm 3.2$ μg/g for zinc and $0.89 \pm 0.16$ μg/g for cadmium. (auth) (UK)

**28763** DETERMINATION OF URANIUM IN URANIFEROUS COAL. Perricos, D. C.; Beikas, E. P. (Democritos Nuclear Research Centre, Athens). Talanta, 16: 745-8(June 1969).

The uranium content of uraniferous coal was determined by neutron activation analysis. Carrier-free $^{239}Np$ was separated quantitatively and selectively by column extraction chromatography with glass powder as support and thenoyltrifluoroacetone in xylene as stationary phase. Only one purification step was involved. (auth) (UK)

**28764** DETERMINATION OF OXYGEN IN HIGH MELTING POINT MATERIALS BY FAST NEUTRON ACTIVATION. Muto, Haruo; Gohshi, Yohichi (Tokyo Shibaura Electric Co.). Bunseki Kagaku, 18: 600-3(May 1969). (In Japanese).

A 14-MeV neutron activation method was applied to the determination of O in samples having a high melting point. The induced activity of a sample was detected with a well-type 5" × 5" NaI(Tl). A nonblocking amplianalyzer made by Toshiba or a M100 modular counting system made by EG & G was used as a measuring system together with two scalers. The discriminator level used was 5.5 to 6 MeV, at which the γ rays from $^{16}N$ alone could be counted. The sensitivity was 1000 counts/mg of O at maximum neutron output except in the case of samples containing Si. In this case, in order to avoid the pile-up phenomena of the measuring system, the sensitivity must be reduced to at least one tenth of the usual one. The standard deviations of this method at the levels of O concentration 0.1 and 0.001% were 5 and 40%, respectively. The time required for analyzing one sample was about 2 min. (NSA of Japan)

**28765** SIMULTANEOUS ROUTINE DETERMINATION OF COPPER AND ZINC IN PLANTS BY NEUTRON-ACTIVATION ANALYSIS. Souliotis, A. G. (Democritos Nuclear Research Center, Athens). Analyst, 94: 359-63(May 1969).

Copper and zinc were determined simultaneously in plant leaves by neutron activation analysis. After ashing the leaves, in the presence of copper and zinc carriers, with fuming nitric and 70% perchloric acids, the solution was evaporated almost to dryness. The residue was treated with 4N hydrochloric acid and the solution transferred to an ion-exchange column containing Dowex 1 × 10, 100 to 200-mesh anion-exchange resin in 6N hydrochloric acid. Copper and zinc were quantitatively eluted with 3 and 0.005N hydrochloric acid, respectively. The radioactivity of each fraction of solution was counted in a multi-channel analyzer by using the 0.51 and 0.44-MeV peak areas of $^{64}Cu$ and $^{69m}Zn$, respectively. Copper and zinc contents were obtained for different kinds of plant leaves. (auth) (UK)

**28766** METHOD FOR MEASURING FISSIONABLE MATERIAL CONTENT OF FUELS. Basdekas, Demetrios L. (to United States Atomic Energy Commission). U. S. Patent 3,436,538. May 1, 1969.

A method for nondestructively assaying nuclear fuel containing $^{235}U$ consists of directing a thermal neutron beam to the fuel under test so that fission neutrons are produced in proportion to the amount of $^{235}U$ present in the fuel, eliminating thermal neutrons of the original beam transmitted through the fuel under test, thermalizing the fission neutrons, activating a dysprosium plate with the thermalized fission neutrons, and measuring the activity of the dysprosium plate. (AEC)

**28767** NUCLEAR REACTION METHOD FOR THE DETERMINATION OF BORON. Juna, J.; Konecny, K.; Vobecky, M. (Nuclear Research Inst., Prague). Collect. Czech. Chem. Commun., 34: 1605-11(May 1969).

A neutron activation method is described in which target nuclei giving activation products with very short life-times or stable nuclei can be used. Pneumatic transportation of the sample from the irradiation position to the radiation detector enables the analysis to be extended even to radionuclides with half-lives of the order of seconds. High values of effective cross sections of certain nuclear reactions allow attention to be given to the radiation produced immediately during the interaction of the beam of incident particles with the target (sample). The sensitivity of the method is given by the effective cross section of the given nuclear reaction, by the neutron flux available to the experimentator, and, to a certain degree, by the decay scheme of the nucleus. A γ spectrometer with a lithium-drifted germanium detector of the coaxial type was used. The determination of B in steel, based on the nuclear reaction $^{10}B(n,\alpha)^{7}Li$, is given as an example of the method. (P.C.H.)

**28768** OPTIMAL NEUTRON ACTIVATION ANALYSIS. Eckhoff, Norman Dean. Manhattan, Kan., Kansas State Univ., 1968. 207p.

Thesis.

Neutron activation analysis (NAA) was used for the routine determination of Cl, Mn, Mg, Ca, K, Br, and Na in many agricultural samples. A gamma spectral analysis correlation algorithm was developed which tests each calculated elemental concentration for significance at the preselected level via the Student's t test. The calculated standard deviation for each elemental concentration includes variance contributions from both the complex and reference spectra. It was found that variance contributions from the reference spectra significantly alter the standard deviations of some of the elemental concentrations, while others were left virtually unchanged. Although the computer memory requirements are large for the correlation algorithm as it was programmed for the IBM 360/50, it is possible to segment the program for adaptation to a smaller computer. The computer time required for each analysis was quite low when many cases were stacked and when the same average weighting matrix was used for each analysis. A method using the criterion of minimization of the total absolute deviations was developed and applied to the analysis of gamma spectra. An original method for the calculation of the standard deviation associated with each of these minimum absolute deviation (MAD) estimators was developed. It was found that, as expected, the MAD estimators had larger standard deviations than the standard deviations of least squares (LS) estimators. MAD estimators have an advantage over LS estimators because many linear constraints can be easily placed on the analysis problem. Because of computer time requirements and standard deviation advantages, LS estimators are, in general, more favorable for the resolution of gamma spectra. Pontryagin's maximum principle was applied to the problem of determining the neutron flux policy which would minimize isotope production costs. It was found that an exponential neutron flux with a positive period corresponding to the mean life of the isotope being produced was the neutron flux which will minimize costs if a quadratic cost function is assumed. Other cost functions were assumed and results are given. The minimization of costs method was combined with a technique for selection of irradiation and decay times which maximize the ratio of the radioactivity of one isotope of a group to the total radioactivity. Results are given for several illustrative isotope mixtures. (Disser. Abstr.)

**28769** NEUTRON ACTIVATION ANALYSIS APPLIED TO ARSENIC DETERMINATION. Lee, Bong Kyu. Ames, Iowa, Iowa State Univ., 1968. 146p.

Thesis.

Instrumental neutron activation analysis was applied to the evaluation of the arsenic content of American cigarettes by utilizing the decay phenomena of $^{76}As$ in the samples. Limitations of the technique and possible error sources were evaluated. Also presented is the experimental feasibility of the samples and the

standard. The cigarette samples investigated contained on the average, 7.69 ± 0.48 μg of arsenic per gram of tobacco. The arsenic content of the cigarette samples differed from one manufacturer to another, ranging from 6.33 ± 0.39 μg to 9.37 ± 0.58 μg of arsenic per gram of tobacco. Manganese-55 has been found to be a component of cigarette samples. Also found was $^{210}$Po. An estimated sensitivity was 0.1 ppM of arsenic with a reactor thermal-neutron flux of $6 \times 10^{10}$ n/cm$^2$/sec and an irradiation time of one hour. The calculated error was 3.6%, for one sample on the average, through the experiment. (Disser. Abstr.)

**28770** DETERMINATION OF W AND Au CONTENT IN MINE WATERS BY NEUTRON ACTIVATION ANALYSIS. Abdullaev, A. A.; Zakhidov, A. Sh.; Nishanov, P. Kh. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 5, 60-1(1968). (In Russian).

Neutron activation analysis was used for determining the content of W and Au in mine waters. The specimens were irradiated in a reactor by $1.8 \times 10^{13}$ n/cm$^2$/sec. The gamma spectra of the specimens were taken by multi-channel pulse analyzer AU-100-1 with scintillation transducer with a 40 × 40 mm NaI(Tl) crystal. The content of elements in water was calculated by the photopeaks of 0.072 ($^{187}$W) and 0.41 ($^{198}$Au) MeV formed in the (n,γ) reaction. Effective cross sections of the activation of stable isotopes $^{186}$W and $^{197}$Au are 35 and 98 barns, respectively. The isotopic content of the natural mixture was 28.64 and 100%, respectively, with $^{187}$W half-life 24 hr and $^{198}$Au 65 hr. Data are tabulated on the analysis of W and Au in the irradiated specimens. (R.V.J.)

## Inorganic, Organic, and Physical Chemistry

*Refer also to abstracts 28674, 28690, 28721, 28900, 28950, 28959, 28975, 28992, 29981, 30305, and 30660.*

**28771** (AD-682879) DETERMINATION OF THE DISTRIBUTION COEFFICIENT OF RADIUM AND OF ITS ISOTOPE ThX BETWEEN FUSED AND CRYSTALLINE CALCIUM NITRATE. Khlopin, V. G.; Klokman, V. R.; Pekelnaya, E. G. Translated from Izv. Akad. Nauk SSSR, Ser. Khim., No. 2, 250-2(1953). 5p. CFSTI.

The distribution coefficient of radium and of its isotope ThX between the melt and the crystals of calcium nitrate was determined. It was also found that no enrichment of the solid phase occurs during the distribution of radium between the melt and the crystals of the isomorphous salt. It was demonstrated that radium in the isomorphous group of nitrates of Ca, Sr, Ba, and Pb easily forms mixed crystals with the nitrates of calcium and lead, but not with the nitrates of strontium and barium, i.e., its nearest group neighbors. (auth)

**28772** (BMwF-FBK-68-44) ANNUAL REPORT, 1967. (Mainz Univ. (West Germany). Institut fuer Anorganische Chemie und Kernchemie). Sept. 1968. 130p. (In German). Dep.

The report is composed of the following parts: performance of a Triga reactor and Cockcroft-Walton accelerator; rapid chemical separations; decay properties of short-lived neutron-rich nuclei; mass- and charge-distribution in fission; and counting techniques. (auth)

**28773** (CEA-Bib-141) PROPERTIES OF URANIUM(III) AND URANIUM(IV) IN SOLUTION (WATER, NON-AQUEOUS SOLVENTS, MOLTEN SALTS). Petit, Nicole (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). Feb. 1969. 71p. (In French). Dep.

An attempt was made to summarize the main reactions involving solvolysis, oxidation-reduction, and the formation of uranium(III) and (IV) complexes in the various media under consideration. The characteristics of the absorption spectra of uranium(III) and uranium(IV) solutions are presented in table form, as are the values of the oxidation-reduction potential of the couples U(IV)/U(III), U(III)/U(0), and the formation constants for the complexes formed by uranium(IV) with inorganic and organic anions. For each medium, furthermore, the literature references are classified according to the study methods used. (auth)

**28774** (CONF-680810-, pp 47-66) PHOSPHORUS. Striplin, M. M. Jr. (Tennessee Valley Authority, Muscle Shoals, Ala. Div. of Chemical Development).

The lower cost of nuclear power and the higher price of sulfur are causing an increased interest in electric-furnace phosphorus. Advantages of phosphorus over wet-process phosphoric acid are higher concentration, greater usefulness, and ease of handling. The economy and mobility of nuclear power should encourage the production of more phosphorus from low-grade rock at the mines. (auth)

**28775** (CONF-680810-, pp 67-81) EFFECT OF LOW-COST NUCLEAR ENERGY ON THE CHLORINE-CAUSTIC INDUSTRY. Currey, John E. (Hooker Chemical Corp., Niagara Falls, N. Y.).

The long-term effect on the chlorine-alkali industry of low-cost nuclear power is reviewed and arguments for including a chlorine plant in a nuclear-powered agro-industrial complex are presented. Nuclear reactors of the future and their low-cost power may make possible a choice of site locations not available in the past; manufacturing costs of chlorine and caustic will decrease. The plants in large industrial and agro-industrial complexes can be used to produce hydrochloric acid to treat the feed to desalination plants producing fresh water. (auth)

**28776** (CONF-680810-, pp 83-92) ACETYLENE AND LOW-COST POWER. Lobo, Walter E.

The various processes for the manufacture of acetylene are briefly reviewed with particular emphasis on those processes that use electrical energy as the main energy source. The cost of energy, although important, is not considered a large enough factor that low-cost power would revolutionize the acetylene-production picture. (auth)

**28777** (CONF-680810-, pp 93-105) FIXATION OF NITROGEN IN ARC PROCESSES. Timmins, R. S. (Abcor, Inc., Cambridge, Mass.).

The availability of cheap electrical energy would open the way to use of the electric-arc process for direct fixation of nitrogen from the air. The chemistry of air at high temperatures has been defined. The route to an economically successful process can be determined from this base. Two approaches to a process are discussed. The frozen equilibrium method utilizes rapid quench to retain the nitric oxide present in an equilibrium mixture of oxygen and nitrogen at high temperature. On the basis of past experiment and thermodynamic calculation, conditions of pressure, temperature, and composition, which minimize the electrical energy requirements, are presented. The second approach involves the generation by an arc of active species, which subsequently reacts to form nitric oxide. Both thermal and cold discharges are discussed. The economics of the process is very strongly controlled by the electrical energy requirements for formation of nitric oxide. Rough cost estimates show that the requirement must be in the neighborhood of 2 to 4 kw-hr/lb of NO. (auth)

**28778** (CONF-680810-, pp 107-22) ECONOMICS OF HYDROGEN AND OXYGEN PRODUCTION BY WATER ELECTROLYSIS AND COMPETITIVE PROCESSES. Mrochek, J. E. (Oak Ridge National Lab., Tenn.).

The manufacturing costs of hydrogen and oxygen are estimated for water-electrolysis plants using two types of advanced electrolytic cells: porous-electrode cells and high-temperature vapor-phase cells. Electrolytic plants producing 40 million standard cubic feet of hydrogen and 860 tons of oxygen per day are compared with fossil-fuel plants that use steam reforming and partial-oxidation processes at the same hydrogen-production rates. The cost of electricity required for the electrolytic process using a porous-electrode cell to break even with the fossil-fuel processes ranged from 0.8 to 2.3 mills/kw-hr. If an oxygen credit of $4/ton was assumed, this break-even power cost range increased to 1.5 to 3 mills/kw-hr. The use of electrolytic hydrogen plants as load-leveling devices for power plants is discussed briefly. (auth)

**28779** (CONF-680810-, pp 123-34) PRODUCTION OF AMMONIA USING LOW-COST NUCLEAR ENERGY. Blouin, Glenn M. (Tennessee Valley Authority, Muscle Shoals, Ala.).

It is postulated that expected near-term (10-yr) advances in nuclear electrical power stations and in hydrogen electrolysis cells will reduce costs to the point where electrolytic ammonia will be competitive in areas where conventional hydrocarbon feedstocks must be imported. Furthermore, far-term (20-yr) advances in reactor and electrolysis-cell technology could result in significant economic advantages over conventional ammonia processes. (auth)

**28780** (CONF-680810-, pp 205-18) BLEACHED STRAW PULP MILL FOR AN AGRO-INDUSTRIAL COMPLEX. McGovern, J. N. (Parsons and Whittemore, Inc., New York).

The size and type of a hypothetical pulp mill to be part of an agro-industrial complex and to use residual wheat straw are developed; the choice of a pulping process is discussed; process and material flows for the resultant 500 ton/day bleached sulfate pulp mill are shown. The mill would use power, heat, and water from the complex. The properties of short-fiber straw are compared with those of wood fibers, and a promising market for the straw pulp in the manufacture of book paper in developing countries is indicated. Plant-site factors are mentioned briefly. Capital requirements for the hypothetical mill are estimated at $60 to $65 million. It is considered that the hypothetical mill could be practical. (auth)

**28781** (COO–1182-29) RESEARCH IN HIGH-TEMPERATURE PHYSICAL CHEMISTRY, PARTICULARLY THE VAPORIZATION OF REFRACTORY SULFIDES. Technical Progress Report, April 1, 1968–April 1, 1969. Cater, E. David (Iowa Univ., Iowa City. Dept. of Chemistry). Apr. 15, 1969. Contract AT(11-1)-1182. 20p. Dep. CFSTI.

Work is being carried out to obtain molecular parameters and ground-state degeneracies of high-temperature molecules produced by the vaporization of refractory oxides and sulfides of the transition, rare earth, and actinide metals. Some fluorides are also being studied. The technique and equipment used are described. (M.C.G.)

**28782** (JPRS–48064) LIGHTEST AND THE HEAVIEST ATOMS. [ENLARGEMENT OF PERIODIC TABLE PROPOSED; PROPERTIES AND APPLICATIONS OF POSITRONIUM DISCUSSED]. Gol'danskii, V. I. Translated from Priroda, No. 2, 19-27(1969). 17p.

The properties, formation, and reactions of positronium are discussed, along with the experimental techniques used to observe the indicated variations that take place during positronium annihilation. The synthesis of heavy elements is also discussed in relation to the periodic table and various theories for filling the 7th and 8th periods. (P.C.H.)

**28783** (MIT–905-133) CHEMISTRY PROGRESS REPORT, DECEMBER 31, 1968. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Contract AT(30-1)-905. 102p. Dep. CFSTI.

Five sections are included; an abstract was prepared for each. (D.H.M.)

*For abstracts of individual sections see: 28784, 28932, 30964, 31255, and 31256.*

**28784** (MIT–905-133, pp 79-89) ORGANIC ISOTOPE APPLICATIONS GROUP. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science).

Chlorine isotope effects were utilized in three areas: reaction of triarylmethyl chlorides with fluoride ion in benzene; methanolysis of di-p-nitrophenylphenylmethyl chloride in benzene; and reaction of methyl chloride with tertiary aziridines. Studies of the relation of structure to reactivity in free radical reactions have focussed attention on the stereochemistry of recombination of radical pairs generated from optically active precursors. Analysis of the results of a thorough study of the decomposition of SS-(-)-azobis-$\alpha$-phenylethane indicates that the $\alpha$-phenylethyl radical undergoes 180° rotation, $k_r$ much faster than recombination with the geminate radical, $k_t$; $k_r/k_t \cong 14$ in benzene at 105°. This study provides new insight on the "cage effect" and on the behavior of molecules in liquids. A detailed study was made of the possibility of catalysis of changes in bonding by electron transfer and by hydrogen atom transfer in the rearrangement of diaziridinones to aziridinecarboxamides. In this system catalysis by hydrogen atom transfer agents is efficient; no evidence for electron transfer catalysis was found. (auth)

**28785** (NP–17853) SPECTRAL ANALYSIS OF URANYL COMPOUNDS. Szoke, Jozsef (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1966. 173p. (In Hungarian). Dep.

The spectral properties of uranyl compounds are reviewed, covering the data presented in the journal literature and in specialized monographs. An attempt was made to clarify the correlations between resonance, fluorescence, electron excitations, and spectral transitions and to establish the connection between the spectrum and the type of metal ligand. The experimental work covered low-temperature infrared, ultraviolet, and spectrophotometric measurements. The materials used for the study included simple uranyl salts, their anion and dipole complexes, and uranyl chelates with $UO_2$ ion charges between 2 and 4. The results indicated that the bands in the infrared spectrum are very complex. The reduced validity of the vibration selection rules is to be attributed to the perturbing effect of the ligand-space symmetry; these rules are strictly applicable to units with total symmetry when the result due to perturbation effects is zero. Calculations based on the frequency of normal vibrations indicated that the bonding order of most uranyl compounds is 2.8 ± 0.1. (Dissertation, 141 references) (TTT)

**28786** (NP–17906) VAPOR PRESSURE OF PROTACTINIUM(V) CHLORIDE. Weigel, F.; Hoffmann, G.; Ter Meer, N. (Munich Univ. (West Germany). Institut fuer Anorganische Chemie). [1969]. 12p. (In German). Dep.

The vapor pressure of anhydrous protactinium(V) chloride was measured by means of a pyrex sickle gage in the temperature range from 500 to 600°K. The temperature dependence of the vapor pressure of molten $PaCl_5$ may be described by the equation: ln p (mm Hg) = 17.27 − 7377/T for the temperature dependence of the vapor pressure of solid $PaCl_5$ and the equation ln p (mm Hg) = 23.87 − 11,162/T was obtained. Extrapolation of the first to 760 mm Hg yielded a value of 693°K (= 420°C) for the boiling point of $PaCl_5$. From the vapor pressure data, the following thermodynamic parameters were calculated: entropy of vaporization $\Delta S_v$ = 21.1 eu, heat of vaporization $\Delta H_v$ = 14.65 kcal/mole, entropy of sublimation $\Delta S_s$ = 34.2 eu, and heat of sublimation $\Delta H_s$ = 22.17 kcal/mole. The Gibbs energy at the melting point was calculated to be $\Delta G_m$ = 2.4 kcal/mole. (auth)

**28787** (ORNL-tr–2125) KINETIC STUDY OF THE REACTION OF NITROGEN WITH URANIUM MONOCARBIDE. Herrmann, Franz-Josef (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report CEA-R-3398. 30p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 42649.

**28788** REACTIVELY SPUTTERED THIN FILMS IN THE VANADIUM–OXYGEN SYSTEM USING TRIODE SPUTTERING. Hensler, D. H.; Ross, A. R.; Fuls, E. N. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Electrochem. Soc., 116: 887-9 (June 1969).

The technique of reactive triode sputtering was employed to deposit several of the vanadium oxides in thin-film form. The resistivity, Hall coefficient, and thermoelectric power of the resulting compositions were measured at room temperature and presented along with the partial pressure of oxygen in the sputtering gas. These data are compared with the literature when possible to categorize the observed films. It is shown that $VO_{1.97}$ and lesser oxides are metallic at room temperature as determined by a small Hall coefficient and small thermoelectric power. (auth)

**28789** ELECTRON SPIN RESONANCE STUDIES OF RADICAL ANIONS OF [2,2]PARACYCLOPHANE AND RELATED COMPOUNDS. Gerson, F.; Martin, W. B. Jr. (Eidgenoessische Technische Hochschule, Zurich). J. Amer. Chem. Soc., 91: 1883-91(Apr. 9, 1969).

ESR spectra of the radical anion of [2,2]paracyclophane in a variety of solvents were analyzed. Taken in 1,2-dimethoxyethane solution, the spectra are characteristic of an unassociated species (symmetry $D_{2h}$), whereas in tetrahydrofuran they give evidence of ion-pair formation between the radical anion and an alkali metal cation (symmetry $C_{2v}$). Coupling constants were unequivocally assigned to sets of equivalent protons by means of 4,12-dideuterium substitution. Bromination of [2,2]paracyclophane, an intermediate step in the synthesis of the ring-deuterated derivative, yielded 4,12-dibromo[2,2]paracyclophane, as well as the 4,13 isomer and higher brominated products. The radical anion of [3,3]paracyclophane was also studied and its ESR spectrum discussed in terms of possible conformations. Investigation of this radical anion, together with that of [4,4]paracyclophane, led to the conclusion that the number n of methylene groups separating the two benzene rings in [n,n]paracyclophanes must be larger than three to prevent the unpaired electron from delocalizing over both moieties. In the case of the open-chain compounds, on the other hand, the corresponding requirement is n > 1, as is shown by the ESR study of the radical anions of diphenylmethane, bibenzyl, and bis(4-methylbenzyl). These results suggest that a different mechanism is responsible for the electron transfer between the two benzene rings in the radical anions of bridged and open-chain compounds. Finally, a simple MO model was considered which accounts for the relative energy and the symmetry of the singly occupied orbital in the radical anions investigated. (auth)

**28790** CRYSTAL STRUCTURES AND LATTICE PARAMETERS OF EINSTEINIUM TRICHLORIDE AND EINSTEINIUM OXYCHLORIDE. Fujita, D. K.; Cunningham, B. B.; Parsons, T. C. (Univ. of California, Berkeley). Inorg. Nucl. Chem. Lett., 5: 307-13(Apr. 1969).

The first determinations of the structures of solid compounds of $^{253}Es$ by x-ray diffraction are described. Previous studies had given unsatisfactory results owing to the high rate of radiation damage to the lattice. It appeared likely, however, that under conditions favorable to rapid annealing and resynthesis of the solid compounds lattice order could be maintained to a degree sufficient to yield satisfactory diffraction effects. Details are given of the Es material used, of sample preparation, and of the x-ray diffraction equipment. Diffraction lines were obtained only at temperatures of about 400 to 425°C. It was found that EsOCl exhibited a tetragonal PbFCl type structure at ~430°C with a = 3.97 ± 0.01 Å and c = 6.75 ± 0.02 Å. $EsCl_3$ showed a hexagonal $UCl_3$ type structure at ~425°C, with a = 7.47 ± 0.01 Å and c = 4.10 ± 0.02 Å. The lattice parameters for $EsCl_3$ were corrected to 20°C, using

thermal expansion data for $AmCl_3$ and $PuCl_3$, giving the values a = 7.40 ± 0.02 Å and c = 4.07 ± 0.02 Å. The results for $EsCl_3$ agreed reasonably well with trends for other actinide trichlorides extrapolated to Z = 99. The ionic radius of $Es^{3+}$ was estimated as 0.97 Å, and the molecular volume of $EsCl_3$ as 96.7 Å$^3$. The ionic radius, molecular volume and c parameter continued to decrease in comparison with the lighter actinides, but the a parameter appeared to increase, similarly to $CfCl_3$. (UK)

**28791** MEASUREMENT OF ELECTRICAL CONDUCTIVITY IN MOLTEN FLUORIDES. A SURVEY. Robbins, G. D. (Oak Ridge National Lab., Tenn.). J. Electrochem. Soc., 116: 813-17 (June 1969).

A survey of electric conductivity measurements in molten fluoride systems covering the period 1927 to 1967 is presented. Particular emphasis is placed on cell and electrode material and design, on measuring bridges, and on the frequency dispersion of the measured resistance. It is pointed out that the common practice of measuring resistance with a Wheatstone-type bridge having a parallel resistance and capacitance, $R_p$ and $C_p$, in the balancing arm can result in considerable error if the relation $R_p = R_s[1 + R_p^2C_p^2(2\pi f)^2]$ is not employed in determining the solution resistance $R_s$. The frequency dependence of the measured resistance and the practice of extrapolating measured resistances to infinite frequency vs. $f^{-\frac{1}{2}}$ is examined in terms of electrode process concepts. Recommendations are presented for reducing frequency effects, and a summary of experimental approaches of 16 groups of investigators for 56 molten fluoride systems is given. (auth)

**28792** CONTRIBUTION TO THE STUDY OF THE ETHYL ALCOHOL MOLECULE BY HERTZIAN SPECTROSCOPY. Culot, Jean-Pierre (Univ. Catholique, Louvain, Belgium). Ann. Soc. Sci. Brux. Ser. I, 83: 65-95(Apr. 25, 1969). (In French).

The application of the Watson formula for the centrifugal distortion correction on the rotational energy levels of a non-planar asymmetric-rotor molecule as ethyl alcohol gives us some new attributions on the microwave spectra of the isotopic species $CH_3{}^{13}CH_2OH$, $CH_2DCH_2OH$, $CH_3CD_2OH$, $CH_2CH_3OH$, $CD_3CD_2OH$, and $CD_3CD_2OD$ in the fundamental state of vibration. The assigned transitions correspond to the dipole component along axis of intermediate moment of inertia ($\mu_b$). The analysis of the Stark effect imposes a upper bound to the component $\mu_a$ along axis of least moment of inertia ($\mu_a \leq 0.1\ \mu_b$) for the "trans" form where the hydroxylic atom lies in the plane of the three heavy atoms. (auth)

**28793** STUDY OF THE PURE ROTATION SPECTRA OF TYPE $^aR$ OF VINYL BROMIDE AT MILLIMETER WAVELENGTHS. de Kerckhove Varent, D. (Univ. Catholique, Louvain, Belgium); Bellet, J. Ann. Soc. Sci. Brux. Ser. I, 83: 97-119(Apr. 25, 1969). (In French).

The $^aR$ type transitions of the fundamental state of vibration of the molecule $CH_2CH^{79}Br$ and $CH_2CH^{81}Br$ was observed. These transitions allow accurate determination of the rotational constants B and C, but not of A. To obtain a better precision of the rotational constants, the measurement of the spectrum was carried out up to wavelength of the order of 1.5 mm. A brief description of the apparatus used, is given. The proposed rotational constants must be corrected by the observation of the transitions of type $^aQ$, $^bQ$, and $^bR$. (auth)

**28794** CONTRIBUTION TO THE STUDY OF THE VINYL BROMIDE MOLECULE BY HERTZIAN SPECTROSCOPY. de Kerckhove Varent, D. (Univ. Catholique, Louvain, Belgium). Ann. Soc. Sci. Brux. Ser. I, 83: 120-44(Apr. 25, 1969). (In French).

The pure rotational spectrum of the fundamental vibrational state of molecules $CH_2CH^{79}Br$ and $CH_2CH^{81}Br$ was studied in a frequency range going from 8 to 59 GHz. The assigned transitions are from the type a as well as the b one. The analysis of the hyperfine structure due to the quadripole moment of the bromine nucleus was done through the formula of Bragg and Golden. The quadrupole coupling constants obtained do not differ very much from those proposed by Goedertier. In the calculation of the transitions frequency, two formulas were used: the formula of the asymmetrical non rigid rotator of Kivelson and Wilson applied to the plane molecules and the Watson's formula applied without using the conditions of planeity. Rotation and distortion constants in both cases are proposed, thus allowing the recalculation of the spectra with practically identical accuracy. The results obtained using the second formula confirm well the plane character of the molecule. (auth)

**28795** KINETIC STUDY OF PROTON EXCHANGE BETWEEN THE $Al(OH_2)_6^{3+}$ ION AND WATER IN DILUTE ACID. PARTICIPATION OF WATER MOLECULES IN PROTON TRANSFER. Fong, Dodd-Wing; Grunwald, Ernest (Brandeis Univ., Waltham, Mass.). J. Amer. Chem. Soc., 91: 2413-22(May 7, 1969).

Rates of proton exchange between $Al(OH_2)_6^{3+}$ and $H_2O$ were measured by nuclear magnetic resonance techniques in dilute solution between 0 and 50°C and in the pH range 3.3 to 0.5. Proton exchange results largely from proton transfer rather than from the exchange of whole water molecules. Two kinetic processes were found: acid dissociation of $Al(OH_2)_6^{3+}$, and reaction between $Al(OH_2)_6^{3+}$, $Al(OH_2)_5OH^{2+}$, and two or more water molecules. The rate constant for acid dissociation, $1.1 \times 10^5\ sec^{-1}$ at 30°C, is in close agreement with results obtained by the dissociation field method. Kinetic analysis and HOD–$D_2O$ solvent isotope effects show that acid dissociation is a bimolecular process in which the proton is transferred directly to an adjacent water molecule; e.g., $(D_2O)_5Al(ODH) + OD_2 \rightarrow (D_2O)_5AlOD + HOD_2^+$. The specific rate of acid dissociation increases slightly with the chloride concentration. The second process is formulated conveniently as a symmetrical proton transfer involving hydrated $Al(OH_2)_6^{3+}$ and hydrated $(H_2O)_5AlOH^{2+}$. In $H_2O$, this process appears to be diffusion controlled; the rate constant is high, $9 \times 10^8\ sec^{-1}\ M^{-1}$ at 30°C, and the kinetic isotope effect in HOD–$D_2O$ solvent is fairly small. One of the steps in the kinetic scheme is the dissociation of the hydrogen-bonded hydration complex, $(H_2O)_5Al(OH) \cdot H^*OH$. The rate constant for breaking the $Al(OH) \cdot H^*OH$ hydrogen bond in this process is found to be $4 \times 10^3\ sec^{-1}$ at 30°C. Because of the difference in the participation by water molecules in the two processes, the kinetics for proton exchange is complex; rates are not simply the sum of additive contributions from two separate processes. (auth)

**28796** MICROWAVE SPECTRUM, STRUCTURE, AND DIPOLE MOMENT OF CIS-THIONYLIMIDE. Kirchhoff, William H. (National Bureau of Standards, Washington, D. C.). J. Amer. Chem. Soc., 91: 2437-42(May 7, 1969).

The microwave spectrum of thionylimide, HNSO, was observed and assigned to the planar cis form. (All isotopically substituted species were studied). The structural parameters are $d_{NH}$ = 1.029 ± 0.01 Å, $d_{NS}$ = 1.512 ± 0.005 Å, $d_{SO}$ = 1.451 ± 0.005 Å, ∠HNS = 115.8 ± 1°, and ∠NSO = 120.4 ± 0.5°, where the uncertainties are estimated to account for the effects of zero-point vibations. The dipole moment and its components along the principal axes in the $NH^{18}SO$ isotopic species are $\mu_a$ = 0.893 ± 0.003 D, $\mu_b$ = 0.181 ± 0.005 D, and $\mu$ = 0.911 ± 0.003 D, where the uncertainties are the standard deviations of the reported values, from the least-squares analysis. Since no attempts were made to make a complete assignment of the impure sample, no comments can be made about the possible existence of trans-HNSO. (auth)

**28797** STRUCTURE-CATALYTIC EFFICIENCY RELATIONSHIPS IN U–Sb OXIDE ACRYLONITRILE SYNTHESIS CATALYSTS. Grasselli, R. K.; Callahan, J. L. (Standard Oil Co., Cleveland). J. Catal., 14: 93-103(May 1969).

A novel uranium–antimony oxide catalyst, which has recently entered full-scale commercial production and use, is shown to be highly effective for the direct oxidation of propylene–ammonia to acrylonitrile. Direct single-step conversion of propylene feed to acrylonitrile in excess of 80% was achieved in a laboratory-scale fluidized-bed reactor. Approximately 6% of the propylene is converted to HCN, less than 1% to acetonitrile, and only traces to condensable oxygenated organics. The interdependence of catalytic efficiency, catalyst crystalline structure, low-frequency infrared spectral characteristics, electron spin resonance behavior, and catalyst composition is discussed. Antimony–uranium containing crystalline phases were identified and correlated to effectiveness in acrylonitrile synthesis. (auth)

**28798** RHODIUM COMPLEX WITH CARBON DIOXIDE. Iwashita, Yuji; Hayata, Atsuko (Ajinomoto Co., Inc., Kawasaki, Japan). J. Amer. Chem. Soc., 91: 2525-8(May 7, 1969).

By a reaction of $Rh_4(CO)_{12}$ with $P(C_6H_5)_3$, a rhodium carbonyl–triphenylphosphine complex (complex I) was prepared. This rhodium(0) complex is easily oxidized by molecular oxygen in aromatic solvents to give a new type of complex (II). Elemental analysis and other evidence indicate that this complex (II) has the moleculer formula $Rh_2(CO)_2(CO_2)(P(C_6H_5)_3)_3L_n$ (L = benzene, toluene, o-, m-, and p-xylene, or mesitylene). By the use of $^{18}O_2$, the course of the oxidation reaction was examined. The infrared spectra of the normal and deuterated complex II were observed, and it was concluded that the coordinated carbon dioxide has a bent form. (auth)

**28799** INFRARED SPECTRA OF SILICON DIFLUORIDE IN NEON AND ARGON MATRICES. Hastie, J. W.; Hauge, R. H.; Margrave, J. L. (Rice Univ., Houston, Tex.). J. Amer. Chem. Soc., 91: 2536-8(May 7, 1969).

The species $SiF_2$, produced by the reduction of $SiF_4$ over Si metal at 1150°C, was isolated in solid neon and argon. From infrared absorption spectra the symmetric and antisymmetric fundamental frequencies were obtained for the various natural isotopic species of SiF2. Also from these measurements the bond angle of $SiF_2$ was calculated and found to be in good agreement with the known gas-phase value, thus indicating the absence of appreciable matrix effects. Absorptions attributable to polymeric $SiF_2$ were also observed. (auth)

**28800** SECONDARY DEUTERIUM ISOTOPE EFFECTS IN RADICAL-FORMING REACTIONS. III. THE DECOMPOSITION OF ACETYL PEROXIDE. Koenig, T.; Cruthoff, R. (Univ. of Oregon, Eugene). J. Amer. Chem. Soc., 91: 2562-9(May 7, 1969).

The $\alpha$-deuterium secondary kinetic isotope effect on the decarboxylation of the acetoxy radical was estimated from the ratio of yields of the two isomeric trideuterated methyl acetates formed from decomposition of unsymmetrically trideuterated acetyl peroxide. The estimated isotope effect is $1.09 \pm 0.02$ for three deuterium atoms. The isotope effects on the over-all decomposition rates were measured by a new double-labeling technique. These isotope effects age small and appear to be sensitive to changes in temperature and solvent viscosity. They are interpreted in terms of a mechanism in which diffusive separation of the acetoxy-acetoxy radical pair is included. (auth)

**28801** SEMIEMPIRICAL MOLECULAR ORBITAL METHOD FOR ESTIMATING THE HYPERCONJUGATIVE CONTRIBUTION TO $\beta$-SECONDARY DEUTERIUM ISOTOPE EFFECTS. Koenig, T.; Wolf, R. (Univ. of Oregon, Eugene). J. Amer. Chem. Soc., 91: 2569-74(May 7, 1969).

A semiempirical equation is derived to connect $\omega$-SCF molecular orbital wave functions and eigenvalues with the hyperconjugative contribution to $\beta$-secondary deuterium isotope effects. The results of the application of this equation to a number of hydrocarbon systems are discussed. (auth)

**28802** SECONDARY DEUTERIUM ISOTOPE EFFECTS IN RADICAL-FORMING REACTIONS. IV. CONCERTED PERESTER DECOMPOSITIONS. Koenig, T.; Wolf, R. (Univ. of Oregon, Eugene). J. Amer. Chem. Soc., 91: 2574-9(May 7, 1969).

The secondary deuterium isotope effects on the rates of decomposition of t-butyl peresters of phenylacetic (1), hydratropic (2), $\alpha,\alpha$-dimethylphenylacetic (3), and pivalic acids were determined by infrared, galvinoxyl, and double-labeling methods. The $\alpha$ effects for 1 and 2 are 1.03 to 1.06 per deuterium. The $\beta$ effects for the series are 1.014 to 1.020 per deuterium. The implications of these effects with respect to the detailed mechanisms of the reactions are discussed. (auth)

**28803** COMPLETE CONFORMATIONAL ANALYSIS OF 3-PHENYLPROPANOL. Snyder, Eugene I. (Univ. of Connecticut, Storrs). J. Amer. Chem. Soc., 91: 2579-82(May 7, 1969).

The NMR spectrum of the aliphatic protons in $PhCH_2CH_2CH_2OH$ was completely analyzed with the aid of various stereospecifically dideuterated derivatives. It is shown that the conformer with Ph, $CH_2OH$ trans disposed is more stable than the gauche rotamer by 0.5 kcal $mole^{-1}$. In contrast, the rotamers with $PhCH_2$, OH trans and gauche, respectively, are about statistically populated. Two kinds of differential isotope effects on chemical shifts are noted. (auth)

**28804** EFFECTS OF STRUCTURE ON THE RATES OF NEUTRALIZATION AND THE IONIZATION CONSTANTS OF NITROCYCLOALKANES. Flanagan, P. W. K.; Amburn, H. W.; Stone, H. W.; Traynham, J. G.; Shechter, H. (Ohio State Univ., Columbus). J. Amer. Chem. Soc., 91: 2797-8(May 7, 1969).

The structural influences on the kinetics and the thermodynamics of formation of cycloalkanenitronates were evaluated. Neutralizations of nitrocycloalkanes were studied as second- and as first-order processes using rapid conductometric methods. The conductometric reactivities for neutralization of nitrocycloalkanes are $4 > 5 > 7 > 8 > 6 \gg 3$. Some results obtained were: nitrocyclobutane neutralizes faster than any of its higher homologs; nitrocyclopropane does not undergo conductivity changes; the reactivity order of the $C_4$ to $C_8$ nitrocycloalkanes is not altered by bases of different strengths; and except for nitrocyclopropane, nitrocycloalkanes neutralize more rapidly than their acyclic analogs. The kinetic results for the neutralization of 1-deuterionitrocyclobutane, 1-deuterionitrocyclopentane, and 1-deuterionitrocyclohexane by hydroxide do not reveal any difference in reaction mechanism of these homologs. The near-maximum isotope effects observed, $k_H/k_D = 8.3$ to 8.9 at 0°C, indicate that in the neutralization of nitrocycloalkanes the reacting carbon–hydrogen bond is highly broken and the one between hydroxide and the removable proton is weakly developed. (D.H.M.)

**28805** CONTRIBUTION TO THE KNOWLEDGE OF THORIUM–NITROGEN COMPOUNDS. Juza, R.; Gerke, H. (Christian Albrechts Univ, Kiel). Z. Anorg. Allg. Chem., 363: 245-57(Dec. 1968). (In German).

Thorium nitride imide, $Th_2N_2(NH)$ was prepared from thorium and ammonia at 400 to 550°C and 2,500 to 5,500 atm. The compound is an analogue of $Th_2N_2O$; the crystal structure corresponds to a monoclinic distorted $La_2O_3$ lattice. A new modification of $Th_3N_4$ was obtained by thermal degradation of $Th_2N_2(NH)$, or by quenching samples prepared by heating $Th_3N_4$ and $ThO_2$ together. This $\beta$-$Th_3N_4$ is isotypic with $Th_2N_2(NH)$; the transformation of this compound to $\alpha$-$Th_3N_4$ is monotropic. (JPRS)

**28806** VIBRATIONAL SPECTRA AND STRUCTURE OF SMALL-RING COMPOUNDS. XII. PROPYLENE IMINE AND PROPYLENE IMINE-$d_1$. Durig, J. R.; Bush, S. F.; Harris, W. C. (Univ. of South Carolina, Columbia). J. Chem. Phys., 50: 2851-63(Apr. 1, 1969).

The infrared spectra of propylenimine and propylenimine-$d_1$ have been recorded from 33 to 4000 $cm^{-1}$ in the gas phase and from 250 to 4000 $cm^{-1}$ in the liquid phase. The Raman spectrum of the liquid phase has also been recorded. The assignment of the 27 normal vibrations has been made based upon band position, intensity, and isotopic shift. The cis and trans isomers have been observed and the barrier to internal rotation of the methyl group in the cis and trans forms has been calculated to be 2.97 and 2.51 kcal/mole, respectively. The intensity of the 3220 $cm^{-1}$ line of propylene imine has been studied as a function of temperature. The $\Delta H^0$ for H-bond formation was found to be $-1262$ cal/mole. Thermodynamic functions have been calculated for the temperature range 200 to 1000°K on the basis of a rigid rotator, harmonic oscillator model for all vibrations except the internal rotation for which appropriate corrections have been made. (auth)

**28807** EFFECT OF CHANGING pH UPON THE KINETIC $^{13}C$-ISOTOPE EFFECT IN THE DECARBOXYLATION OF 4-METHOXYANTHRANILIC ACID. Dunn, G. E.; Buccini, J. (Univ. of Manitoba, Winnipeg). Can. J. Chem., 46: 563-6 (Feb. 15, 1968).

The $^{13}C$-carboxyl kinetic isotope effect on decarboxylation of 4-methoxyanthranilic acid was determined in aqueous solutions of ionic strength 0.50 at 60°C. The isotope effect, $100(k_{12}/k_{13} - 1)$, is found to be 4.2% at pH −0.3, 1.4% at pH 1.3, and zero at pH 4.0. This information makes it possible to decide between two mechanisms previously proposed in favor of the one in which both anion and neutral acid are protonated anion decarboxylates. (auth) (CANADA)

**28808** PARAHYDROGEN ENRICHMENT AND HYDROGEN–DEUTERIUM EQUILIBRATION AT LOW TEMPERATURES ON OXIDES OF THE FIRST TRANSITION SERIES. Pearce, D. R.; Richardson, P. C.; Rudham, R. (Univ. of Nottingham, Eng.). Proc. Roy. Soc. (London), Ser. A, 310: 121-35(Apr. 29, 1969).

Parahydrogen enrichment on eleven first transition series metal oxides was investigated at 77 and 90°K over the pressure range 1 to 200 Torr. The order of activity at 77°K and 10 Torr was found to be: $Fe_2O_3 > Co_3O_4 > CoO > MnO > NiO > V_2O_3 > Cr_2O_3 > CuO > ZnO > V_2O_5 > TiO_2$. This activity series is interpreted in terms of the paramagnetic mechanism in which the rate is dependent upon the magnetic properties of the metal ions arising from their 3d electronic configuration. Comparison of the pressure dependencies for enrichment with those of hydrogen adsorption isotherms at 77 and 90°K suggests that enrichment occurs on a small fraction of the oxide surface. The rates of hydrogen–deuterium equilibration at 10 Torr were measured on the eleven oxides at 297°K, and at 77 and 90°K both before and after exposure to hydrogen at 297°K. The order of activity at 297°K was found to be: $Co_3O_4 > CoO > NiO > Cr_2O_3 > V_2O_3 > ZnO > CuO > Fe_2O_3 > MnO > TiO_2 > V_2O_5$. This activity series confirms, at a single reaction temperature on well-sintered oxides, the twin-peaked activity pattern previously found for this reaction (Dowden, Mackenzie and Trapnell, 1956). At 77 and 90°K the simple twin-peaked activity pattern was not observed and high activity was confined to $V_2O_3$, $Co_3O_4$ and NiO, and to CoO after exposure to hydrogen at 297°K. (auth) (UK)

**28809** STRUCTURE OF THORIUM CHELATES WITH SEVERAL FLAVONOIDS. Golovina, A. P.; Alimarin, I. P. Vestn. Mosk. Univ., Ser. II. Khim., No. 2, 120-1(Mar.-Apr. 1969). (In Russian).

Thorium complexes with quercetin and quercitrin were prepared and their ir spectra investigated. These flavonoids were found to react with thorium by carbonyl and 3- or 5-hydroxyl groups in flavone. (auth)

**28810** CUBIC CO-ORDINATION: CRYSTAL STRUCTURE OF SODIUM OCTAFLUOROPROTACTINATE(V). Brown, D.; Easey,

J. F.; Rickard, C. E. F. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., A, No. 7, 1161-4(1969).

The structure of sodium octafluoroprotactinate(V), $Na_3PaF_8$, was determined by x-ray diffraction methods and refined by full-matrix least-squares techniques. The crystals are of tetragonal symmetry, in space group I4/mmm ($D_{4h}^{17}$) with a = 5.493 and c = 10.970 Å; Z = 2. Each protactinium atom is bonded to eight fluorine atoms, which lie at the corners of an almost perfect cube. The Pa–F bond distance is 2.21 Å. The sodium atoms are located between the $PaF_8^{3-}$ cubes. Metal–fluorine and fluorine–fluorine distances were calculated for the isostructural uranium and neptunium compounds, $Na_3UF_8$ and $Na_3NpF_8$, respectively. (auth) (UK)

**28811** OXIDATION OF SOME NIOBIUM ALLOYS. Tsyrlin, M. S.; Kovba, L. M. Vestn. Mosk. Univ., Ser. II. Khim., No. 2, 61-5(Mar.-Apr. 1969). (In Russian).

The phase composition and ratio of $6ZrO_2 \cdot Nb_2O_5/Me_{12}O_{28}$ Me = metal in scale formed by the oxidation of Nb–Zr–Ti alloys at 550 to 950°C were studied. It was found that oxidation kinetics of the alloys studied could be described by Evans' relation in this temperature range. Parabolic and linear constants of oxidation were calculated. (auth)

**28812** KINETICS OF REACTION OF URANOSO-URANIC OXIDE WITH SODIUM CARBONATE. Efremova, K. M.; Ipolitova, E. A. Vestn. Mosk. Univ., Ser. II. Khim., No. 2, 52-6(Mar.-Apr. 1969). (In Russian).

The rate of interaction of uranoso-uranic oxide with sodium carbonate was found to depend on the dimension of reagent grains. The fine-grained components reacted most readily. An interaction was observed at 400°C. The reaction took a normal course at elevated temperatures. At first the process was limited by the chemical reaction and then by sodium carbonate diffusion to the grains of uranoso-uranic oxide through the layer of $Na_2U_2O_7$. (auth)

**28813** THE INFLUENCE OF ADDING ALKALI AND ALKALINE-EARTH SALTS ON THE VOLATILITY OF CARRIER-FREE $^{137}Cs$ CHLORIDE AT ELEVATED TEMPERATURE. Blume, W.; Korsetz, B. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Isotopenpraxis, 5: 75-7(Feb. 1969). (In German).

For determining the influence of foreign salts on $^{137}Cs$ volatility during ashing of biological samples carrier-free $^{137}Cs$ chloride was heated in platinum dishes in the presence of different alkali and alkaline earth salts at 350 to 600°C, and the losses occurring were measured. Sodium, potassium, nitrate, chloride, and carbonate ions essentially increased the losses, while phosphate and sulfate ions strongly reduced the volatility of the carrier-free $^{137}Cs$. Conclusions for ashing biological samples were drawn. (auth)

**28814** OXYFLUORIDES OF PENTAVALENT URANIUM WITH PYROCHLORIC STRUCTURE. Kemmler-Sack, S. (Univ., Tuebingen, Ger.). Z. Anorg. Allg. Chem., 363: 282-94(Dec. 1968). (In German).

The pyrochlore-type compounds $A'AU_2O_6F$, with A' = $Na^+$, $K^+$, $Rb^+$, $Tl^+$ and A = $Sr^{++}$, $Pb^{++}$ and $Ba^{++}$, space group $O_h^7$–Fd3m were prepared. According to the magnetic and spectroscopic properties of these compounds, cubic uranium–oxygen octahedrons are present only in $KSrU_2O_6F$, $RbSrU_2O_6F$, $KBaU_2O_6F$, and $RbBaU_2O_6F$, while in all other compounds reported the octahedrons are distorted. (JPRS)

**28815** KINETIC STUDY AND MORPHOLOGY OF THE SULFURIZATION OF POWDERED THORIUM BY HYDROGEN SULFIDE. Toesca, Serge; Le Boete, Frederic; Colson, Jean-Claude; Delafosse, Denise (CNRS, Dijon, France). Compt. Rend., Ser. C, 268: 1099-1102(Mar. 24, 1969). (In French).

The sulfurization of powdered thorium by hydrogen sulfide at low pressure leads to the formation of $Th_{7-\epsilon}S_{12}$ between 440 and 540°C. The curves for the progress of the reaction and the morphology of the sulfide formed indicate that the major process that determines the speed of the transformation is the external interfacial reaction, which is in agreement with the law for the speed as a function of the pressure. (tr-auth)

**28816** SPECTROPHOTOMETRIC STUDIES ON COMPLEXES OF $Cu^{2+}$ AND $UO_2^{2+}$ IONS. Ramamoorthy, S.; Santappa, M.; Raghavan, A.; Vijayaraghavan, V. R. (Univ. of Madras). J. Inorg. Nucl. Chem., 31: 1851-7(June 1969).

The results of complexometric studies on systems of uranyl ion–thioglycolic acid, uranyl ion–pyruvic acid, and cupric ion–pyruvic acid by spectrophotometry in the pH range where hydrolysis of the metal ions is negligible are reported. Log $K_{ML}$ values for the complexes are given. (UK)

**28817** ABSORPTION SPECTRUM OF $Np^{4+}$ IN SINGLE-CRYSTAL THORIUM OXIDE. Gruber, J. B.; Menzel, E. R. (Washington State Univ., Pullman). J. Chem. Phys., 50: 3772-9(May 1, 1969).

The optical absorption spectrum of $Np^{4+}$ in single-crystal $ThO_2$ was investigated at 4°K, 77°K, and room temperature between 0.3 and 2.5 $\mu$. Infrared spectra were recorded between 2.5 and 300 $\mu$. Intermediate-coupling wave functions and eigenvalues for the ground-state electronic configuration $5f^3$ were generated by an IBM 360-67 program using the combined Coulombic and spin–orbit Hamiltonian. The best over-all agreement between calculated free-ion J levels and the observed spectrum of $Np^{4+}$ are obtained with the Racah parameters, $E^1$ = 3185, $E^2$ = 18.50, $E^3$ = 323.2, and the spin-orbit parameter $\zeta$ = 2009 in $cm^{-1}$. A six-parameter calculation that includes the effect of configuration interaction yields the parameters $E^1$ = 3160, $E^2$ = 17.59, $E^3$ = 323.2, $\zeta$ = 1983, $\alpha$ = 22.44, and $\beta$ = −575.9 in $cm^{-1}$. Intermediate-coupling wavefunctions were used to calculate operator equivalent factors. A first-order crystal-field analysis was carried out for the six lowest J manifolds, where the separation of adjacent J levels is large compared to the crystal-field splitting of each J level. For $Np^{4+}$ in an eightfold cubic environment, the crystal-field parameters $B_4$ = −410 $cm^{-1}$ and $B_6$ = 50.4 $cm^{-1}$ predict the positions of the crystal quantum states in good agreement with experiment. (auth)

**28818** THE REACTION OF GASEOUS BROMINE TRIFLUORIDE WITH $U_3O_8$. Jarry, R. L.; Steindler, M. J. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 31: 1847-9(June 1969).

The results of a study on the kinetics of the reaction of gaseous $BrF_3$ with $U_3O_8$ in the temperature range 100 to 400°C and the $BrF_3$ partial pressure range 18 to 44 torr are reported. An attempt was also made to verify the minimum in the reaction rate reported previously by others, which was reached at a temperature of about 230°C and a $BrF_3$ partial pressure of 10 torr. (P.C.H.)

**28819** A SPECTROPHOTOMETRIC STUDY OF TRIVALENT ACTINIDE COMPLEXES IN SOLUTIONS. III. AMERICIUM WITH BROMIDE, IODIDE, NITRATE, AND CARBONATE LIGANDS. Shiloh, M.; Givon, M.; Marcus, Y. (Israel Atomic Energy Commission Yavne). J. Inorg. Nucl. Chem., 31: 1807-14(June 1969).

The light absorption spectra of americium(III) in concentrated aqueous lithium bromide, iodide, and nitrate, magnesium iodide, potassium carbonate, and nitric acid were studied, together with those of extracts into triisooctylammonium nitrate solutions in xylene. Effective stability constants for the first (inner sphere) complex are: log $\beta_1^* = -1.3 \pm 0.1$ for $AmNO_3^{2+}$ and $-3.3 \pm 0.1$ for $AmBr^{2+}$; the iodide complex was much weaker than the bromide. Solubility studies showed that $[Am(OH)(CO_3)_3]^{4-}$ exists in 0.1 to 0.6 M potassium carbonate solutions. The spectral changes are discussed in terms of the environmental effects on the 5f-5f transitions in americium(III). (auth) (UK)

**28820** ISOTOPIC EXCHANGE BETWEEN NONVOLATILE COMPOUNDS AND HEAVY WATER IN INERT SOLVENT. Iogansen, A. V.; Rozenberg, M. Sh. Zh. Prikl. Spektrosk., 9: 1027-30(Dec. 1968). (In Russian).

A method of effective rapid and economical production of compounds containing OD and ND by stepwise exchange with $D_2O$ in an inert solvent is proposed. The consumption of $D_2O$ and manipulations with the substances were reduced to a minimum. Two variations of equipment and methods are described. Examples of application are given. (M.C.G.)

**28821** RADIOINDUCED ELECTRIC CONDUCTIVITY OF POLYMERS IN A HIGH-INTENSITY ELECTRIC FIELD. Gusynin, V. I.; Kasimovskaya, E. E.; Tal'roze, V. L. Khim. Vys. Energ., 3: 61-4(Jan.-Feb. 1969). (In Russian).

The volt-ampere characteristics were obtained for thin films of organic polymers (polyethylene, polypropylene, polystyrene) that were irradiated by fast electron beams at room temperature. The relation of the induced electric conductivity to the voltage for specimens of polypropylene and polystyrene was found to be close to exponential and the relation to radiation dose rate (in the range of rapidly increasing current) was close to linear. Experiments were conducted in order to find possible additional actions on material accelerated in an electric field by slow electrons. The yield of radicals, measured by electron paramagnetic resonance method, was found to be equal when irradiated in or out of an electric field (within the limits of experimental error). The results can be explained only by the fact that the polymer molecules are not ionized and must be due to ions of impurities or to characteristics of the structure. (tr-auth)

**28822** RADIOINDUCED OXIDATION OF 1-HEPTENE. Sydykova, D. S.; Saraeva, V. V.; Bakh, N. A. Khim. Vys. Energ., 3: 65-70(Jan.-Feb. 1969). (In Russian).

The kinetics of the formation of hydrogen peroxide, carbonyl compounds, and alcohols by the $\gamma$-induced oxidation of 1-heptene

was examined. The kinetic rules were analogous to those previously observed by the radioinduced oxidation of the alkanes. For example, carbonyl compounds and alcohols show that transformation of the double bond does not occur in the oxidation process, but is partially shifted from the alpha to the beta position. Heptene oxide is formed in low yields. (tr-auth)

**28823** MASS SPECTROMETRIC INVESTIGATION OF REACTIONS OF EXCITED ATOMS AND MOLECULES. II. THE IONIZATION PROCESSES IN WATER, ACETYLENE, AND IN MIXTURES OF ACETYLENE AND WATER WITH DEUTERIUM AND HYDROGEN. Kupriyanov, S. E. Khim. Vys. Energ., 3: 17-22(Jan.-Feb. 1969). (In Russian).

The processes involved in the formation of different ions as a result of single collisions of excited atoms or molecules of hydrogen and deuterium with nonexcited molecules of water and acetylene were studied. The main contribution in the formation of the ions $H_3O^+$, $DH_2O^+$, $C_2H_3^+$, $C_2H_2D^+$ is made by the metastable molecules $H_2^m$ and $D_2^m$ in the triplet state $c^3\pi u$ and by H and D atoms in the 2 S state. At greater pressures it is probable that the short-lived optically excited molecules participate. (tr-auth)

**28824** COMPLEXES OF URANYL ION WITH BUTYRIC AND ISOBUTYRIC ACIDS. Ramamoorthy, S.; Raghavan, A.; Santappa, M. (Univ. of Madras). J. Inorg. Nucl. Chem., 31: 1765-9 (June 1969).

Systems of uranyl ion with butyric and isobutyric acids were studied by pH titration at 31 ± 0.1°C and $\mu$ = 0.1 ($NaClO_4$). 1:1 and 1:2 uranyl:acid complexes with isobutyric and butyric acids were detected in the pH range 1.5 to 3.5. The stability constants log $K_{ML_1}$ = 3.40, log $K_{ML_2}$ = 2.43 for isobutyric acid and log $K_{ML_1}$ = 2.91, log $K_{ML_2}$ = 1.62 for butyric acid were determined. (auth) (UK)

**28825** ON THE FREE ENERGY OF FORMATION OF THORIUM MONOCARBIDE. Potter, P. E. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 31: 1821-9(June 1969).

An assessment of the free energies of formation of thorium monocarbide was made from equilibria in the plutonium–thorium–carbon and thorium–carbon–oxygen systems for the temperature range 1373 to 1873°K. The data are consistent with a negative entropy of formation. (auth) (UK)

**28826** JOINT STUDY OF THE ISOMERIZATION AND EXCHANGE WITH DEUTERIUM OF THE CIS- AND TRANS-ISOMERS OF 1,2-DIMETHYLCYCLOHEXANE ON NICKEL. Shopov, D.; Andreev, A.; Petrov, L.; Goudkov, B. (Inst. of Organic Chemistry, Sofia). Compt. Rend. Acad. Bulg. Sci., 22: 177-80(1969).

The results of deuterium exchange and configuration isomerization kinetic investigations, as well as some data on exchange, are given: At lower temperatures, where the configuration differences are better expressed, a considerable difference exists between the rates of the deuterium-hydrogen exchange of the two isomers. The average number of exchanged hydrogen atoms in the molecule of the cis-isomer at 177°C is 10, whereas for the trans-isomer it is 7.8. (M.C.G.)

**28827** CHEMISTRY OF HIGHLY CONCENTRATED AQUEOUS ELECTROLYTE SOLUTIONS. XVIII. PAPER IONOPHORETIC INVESTIGATION OF THE MOVEMENT OF $Co^{2+}$, $Ni^{2+}$, $Pd^{2+}$, $Pt^{4+}$, AND $UO_2^{2+}$ IONS IN HIGHLY CONCENTRATED LiCl SOLUTIONS. Smirous, F.; Celeda, J. (Technische Hochschule fuer Chemie, Prague). Collect. Czech. Chem. Commun., 34: 1155-61(Apr. 1969). (In German).

The spot transport of selected ions of Group VIIIb and $UO_2^{2+}$ ions was investigated in relation to the LiCl concentration (1 to 10 mol/l). The stability constants of the chlorocomplexes or ion associates were estimated. (tr-auth)

**28828** ISOTOPIC EXCHANGE REACTIONS OF CARBON MONOXIDE WITH RHENIUM PENTACARBONYL HALIDES. Cetini, G; Gambino, O.; Vaglio, G. A.; Ferrari, R. P. (Univ., Turin). Inorg. Chem., 8: 1371-3(June 1969).

Results from a study of the CO isotopic exchange reaction with rhenium pentacarbonyl halides show that the exchange reactions follow a first-order law with respect to the complex, irrespective of CO concentration values, provided these are not less than 8 to 10 mM. A dissociative mechanism is thus involved, in which the slow step consists of the rupture of a Re–Co bond. The specific rate constants follow the order Cl > Br > I. This is in agreement with the increase in order of the Re–C bond from the chlorine to the iodine derivative and is deducible from the shift of the highest C–O stretching frequencies. The effect produced by the solvent was studied on $Re(CO)_5$ Br. Specific rate constants decreased with increasing solvent dielectric constant values. From a comparison of activation parameters for $Re(CO)_5X$ and $Mn(CO)_5X$, it was concluded that the Re derivatives have lower reactivity than the Mn derivatives. (D.H.M.)

**28829** INVESTIGATION OF THE REACTIONS BETWEEN ETHYLENE, HYDROGEN, AND TRITIUM AT A PALLADIUM CONTACT IN A CLOSED CONTINUOUSLY RUNNING APPARATUS. Gaertner, E.; Schuegerl, K. (Technische Univ., Hanover). Chem.-Ing.-Tech., 41: 538-44(May 1969). (In German).

The addition and exchange reactions of hydrogen and tritium with ethylene, which form a series of parallel reactions, have been examined at a palladium contact in a closed recycling apparatus. The rate of the addition reaction proved to be faster than that of the exchange reaction. As was to be expected, the rate of hydrogen addition was faster than that of tritium addition; however, this rate difference decreased steeply with increasing temperature. (auth)

**28830** PREDISSOCIATIONS IN THE DISSOCIATIVE IONIZATION OF FORMALDEHYDE. II. INTERPRETATION OF THE MASS SPECTRA. Guyon, Paul-Marie (Faculte des Sciences Orsay, France). J. Chim. Phys., 66: 467-71(Mar. 1969). (In French).

In order to interpret the mass spectra of $H_2CO$ and $D_2CO$ given previously, the correlation diagrams were established. The excited state $^2B_1$ ($^2A''$) is predissociated by a $^2A'$ state leading to the formation of $HCO^+ + H$ in their ground states respectively $^1\Sigma^+$ and $^2S_g$. The observed isotopic effects happen during this predissociation. (auth)

**28831** BASE-CATALYZED HYDROGEN–DEUTERIUM EXCHANGE IN SOME PYRIDINE N-OXIDES. CHLORO AND N-OXIDE RATE FACTORS AND MECHANISM. Zoltewicz, John A.; Kauffman, Glenn M. (Univ. of Florida, Gainesville). J. Org. Chem., 34: 1405-11(May 1969).

Rates of deuterium–hydrogen exchange for deuterated pyridine N-oxide (I) and 3-chloro- (II) and 3,5-dichloropyridine N-oxide (III) in $CH_3ONa$–$CH_3OH$ were obtained by NMR methods. At 138° relative rates for I-4, I-3,5, and I-2,6 are 1.0, 10, and 1500, respectively. At 50° relative rates for II-4, I-2,6, II-6, III-4, II-2, and III-2,6 are 0.37, 1.0, 12.2, 1370, 1840, and 11,800. Log rate factors (relative to benzene) at 50° for Cl and N-oxide groups are o-Cl = 3.27 ± 0.24; p-Cl = 0.95 ± 0.14; o-NO = 9.58, and p-NO = 5.88. The N-oxide group is one of the most strongly activating groups for carbanion formation yet reported; its effect appears to be largely inductive. The exchange proceeds by direct deprotonation to give carbanions. (auth)

**28832** HYDROLYSIS OF URANIUM NITRIDES. Sugihara, Sunao; Imoto, Shosuke (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo), 6: 237-42(May 1969).

Studies were made on the hydrolysis of uranium nitrides (UN and cubic $U_2N_3$) by superheated steam. The resulting gaseous products were mainly hydrogen, though with $U_2N_3$ the hydrogen generation was replaced by that of nitrogen at higher temperatures. The condensed water contained ammonia, but not hydrazine. Both UN and $U_2N_3$ powders were ultimately converted to $UO_{2.1}$ after hydrolysis at temperatures up to 600°C; intermediate products (formed below 400°C) were presumably $UO_2(N)$ or $UN_{1.7}$ in the case of UN and $UN_{1.8}$ with $U_2N_3$. The reaction mechanisms corresponding to the formation of such chemical species were estimated mainly from the behavior of nitrogen and hydrogen evolution and from the yield of ammonia. The effect brought by $N_2$ atmosphere on the ammonia formation and on the dissolution of nitrogen into solids were studied also by the hydrolysis under flowing $N_2$ gas. It was revealed that the yield of ammonia increased and the dissolution was inhibited by $N_2$ atmosphere. (auth)

**28833** SOLVENT AND ISOTOPE EFFECTS IN THE THIOCARBONYL ELIMINATION OF 4-PHENYLBENZHYDRYL THIOCYANATE. Miotti, Umberto; Ceccon, Alberto (Univ., Padua). Ric. Sci., 38: 824-6(Sept. 1968).

The rates of elimination of H-CN from 4-phenylbenzhydryl thiocyanate and its α-deuterated analog were measured in several alcohol-conjugate base systems. Explanation of the trend of the kinetic isotope effect requires an increase in carbanion character of the transition state as the solvent is changed from tert-butanol to ethanol. (auth)

**28834** TEMPERATURE DEPENDENCE OF THE $D_2O$ AND HOD SPECTRA IN THE NEAR INFRARED UP TO THE SUPERCRITICAL REGION. Luck, W. A. P.; Ditter, W. (Hauptlaboratorium der Badischen Anilin und Soda-Fabrik AG, Ludwigshafen, Ger.). Z. Naturforsch., 24b: 482-94(May 1969). (In German).

The temperature dependence of the ir spectra of $D_2O$ and HOD in the liquid state was investigated under saturation conditions in the supercritical region. Hydrogen bonds are discussed and a simple water model was developed. (M.C.G.)

**28835** OPTICAL ABSORPTION SPECTRA OF OXALATE SOLUTIONS OF PROTACTINIUM(V). Davydov, A. V.; Pal'shin, E. S.; Palei, P. N. Radiokhimiya, 11: 110-12(1969). (In Russian).

The optical absorption spectra of oxalate solutions of protactinium(V) were studied at different concentrations of element and oxalic acid and different values of pH. On the basis of the results obtained it was concluded that optical absorption in the region 235 to 320 resulted from the formation of oxalate complexes of protactinium. It is shown that oxalate solutions of protactinium are stable at pH ≃ 2. The precipitation of protactinium hydroxide from oxalate solutions began at pH > 4 and ended at pH > 10. (tr-auth)

**28836** INVESTIGATIONS OF THE COMPLEX FORMATION OF $Np^{4+}$ WITH FLUORINE IONS IN SOLUTIONS OF $HClO_4$ BY THE METHOD OF IONIC EXCHANGE. Krylov, V. N.; Komarov, E. V. Radiokhimiya, 11: 105-6(1969). (In Russian).

By the method of ionic exchange in solutions of perchloric acid solutions (2 and 1M) at ratios of HF : $Np^{4+}$ from 0.5 to 200, the formation of the $NpF^{3+}$ was shown with formation constants $\beta = (5.0 \pm 0.6) \times 10^4$ and $\beta = (3.6 \pm 0.3) \times 10^4$ in solutions of ionic forces of $\mu = 2$ and $\mu = 1$, respectively. (tr-auth)

**28837** INVESTIGATION OF THE COMPLEX FORMATION OF $Pu^{4+}$ WITH FLUORINE IONS IN SOLUTIONS OF $HNO_3$ BY THE METHOD OF IONIC EXCHANGE. Krylov, V. N.; Komarov, E. V.; Pushlenkov, M. F. Radiokhimiya, 11: 103-4(1969). (In Russian).

By the method of ionic exchange in solutions of $HNO_3$ at $Pu^{4+}$ concentrations of $3.14 \times 10^{-6}$ g-ion/l and concentrations of HF of $(0.33 \text{ to } 96.3) \times 10^{-5}$ M, the existence of the $PuF^{3+}$ complex was observed with a constant of formation of $\beta = (6.0 \pm 0.2) \times 10^3$ in 2M $HNO_3$ and $\beta = (1.1 \pm 0.1) \times 10^4$ in 1M $HNO_3$. (tr-auth)

**28838** INVESTIGATION OF COMPLEX FORMATION OF $Pu^{4+}$ WITH FLUORINE IONS IN SOLUTIONS OF $HClO_4$ BY THE METHOD OF IONIC EXCHANGE. Krylov, V. N.; Komarov, E. V. Radiokhimiya, 11: 101-2(1969). (In Russian).

By the method of cation exchange in solutions with an ionic force of $\mu = 2$ (1.98M $HClO_4$ + 0.02M $HNO_3$) and $\mu = 1$ (0.98M $HClO_4$ + 0.02M $HNO_3$) at HF concentrations of $(0.33 \text{ to } 96.3) \times 10^{-5}$M the existence of the $PuF^{3+}$ complex was observed with the constants of formation of $\beta = (2.8 \pm 0.2) \times 10^4$ and $\beta = (1.6 \pm 0.3) \times 10^4$ for solutions with $\mu = 2$ and 1, respectively. (tr-auth)

**28839** INVESTIGATION OF THE REACTION OF URANIUM WITH AQUEOUS SOLUTIONS OF HYDROXIDES. Vdovenko, V. M.; Romanov, G. A.; Solitseva, L. B. Radiokhimiya, 11: 94-100(1969). (In Russian).

The reaction of uranium tetrafluoride with aqueous solutions of hydroxides was studied. On increasing the pH of solutions of $UF_4$, a staircase-like substitution of the fluorine ions by $OH^-$ ions occurs. Hydrolysis of $UF_4$ is completed at pH = 9.5 by formation of $U(OH)_4$. A compound obtained at pH = 5.2 showed its complete congruity with the previously isolated crystal hydrate $UOF_2 \cdot H_2O$. Addition of fluorine ions to the solution has a strong effect on the beginning of hydrolysis of uranium. (tr-auth)

**28840** THE CATALYTIC ACTIVITY OF THORIUM(IV) IN THE HYDROGEN PEROXIDE–THIOSULFATE SYSTEM. Litvinenko, V. A. Radiokhimiya, 11: 74-9(1969). (In Russian).

The influence of pH on the catalytic activity of thorium in the hydrogen peroxide–thiosulfate systems was studied. A catalytic effect was observed in the range pH = 1.5 to 4.5 and was maximum at pH = 3.5. It was assumed that this is a result of the action of a peroxide complex of the type $Th(O_2H)^{3+}$ dominating near pH ≃ 3.5. It was established that the rate of the catalytic reaction depends linearly on the concentration of thorium. The reaction in the presence of thiorium is characterized by an induction period, the length of which depends on the concentration of the catalyst. (tr-auth)

**28841** DETERMINATION OF THE ASSOCIATION CONSTANTS OF URANYL IONS WITH DIETHYL ESTER OF PHOSPHORIC ACID. Ul'yanov, V. S.; Sviridova, R. A.; Zarubin, A. I. Radiokhimiya, 11: 13-18(1969). (In Russian).

An attempt was made to determine the constants of formation of the first and second complexes of uranyl ions with diethyl ester of phosphoric acid: $UO_2A^+$ and $UO_2A_2$. Ion-exchange and spectrophotometric methods were used for this. In both cases it was supposed that in the ranges of concentration studied more complex complexes can be neglected. Only cation forms were sorbed by the ion-exchange resin. (M.C.G.)

**28842** THE COMPLEXES OF URANIUM(IV) HALIDES WITH ETHYL ACETATE AND ACETONITRILE. Vdovenko, V. M.; Volkov, V. A.; Suglobova, I. G.; Suglobov, D. N. Radiokhimiya, 11: 26-9(1969). (In Russian).

The reactions of chlorides and bromides of uranium with relatively weak bases, ethyl acetate and acetonitrile, were studied. Molecules of these liquids are of interest in that the characteristic frequencies of their functional groups are widely used for comparison of the electron acceptor properties of salts that form donor-acceptor complexes with these substances. By studying the vibrational spectra of uranium halide complexes with ethyl acetate and acetonitrile, an attempt was made to determine their electron-acceptor properties. In acetonitrile the compounds formed were close to the compositions $UCl_4 \cdot 4CH_3CN$ and $UBr_4$ $4CH_3CN$. $UCl_4$ and $UBr_4$ dissolved in ethyl acetate with the formation of a bright green solution. After the removal of excess solvent in a vacuum, the solvates began to crystallize only after long standing. It was concluded that the halides of uranium are very weak electron acceptors. (M.C.G.)

**28843** STRUCTURE OF URANYL COMPOUNDS AND THEIR SPECTRA IN THE VISIBLE REGION. Vdovenko, V. M.; Skoblo, A. I.; Suglobov, D. N. Radiokhimiya, 11: 30-6(1969). (In Russian).

The spectra in the visible region of 30 uranyl compounds, mainly anionic complexes with tetradecylammonium cations, were measured. It was established that the first position from the side of low frequencies of the band for vibrational structure depends on the coordination number of $UO_2^{2+}$ and basic ligands. This relation is explained as a result of the influence of the electrostatic field of residual charges in ligands on the main exchange position and the excited electronic levels of the uranyl ion. The relation of the relative intensity of the first and second electronic transitions in the spectrum to the symmetry of the uranyl complex was noted. (tr-auth)

**28844** THERMOCHEMICAL CHARACTERISTICS OF CRYSTALLINE HALIDES AND OXIDES OF RARE EARTH AND ACTINIDE ELEMENTS. Krestov, G. A.; Krestova, N. V. Radiokhimiya, 11: 62-74(1969). (In Russian).

A systematic study was made of the energy and thermal capacities of crystalline halides and oxides of rare earth and actinide elements. On the basis of the character of their change, some conclusions were drawn concerning the presence of a crystal field effect. The linear and volumetric coefficients of thermal expansion were examined. The numerical values of these quantities were calculated. (tr-auth)

**28845** THORIUM (HEXAMETHYLENEDINITRILO)TETRAACETATE. Podkorytova, N. V.; Skorik, N. A. Radiokhimiya, 11: 115-16(1969). (In Russian).

The stability constant for thorium complexes with (hexamethylenedinitrilo)tetraacetic acid, based on data for the solubility of the complex in 0.1M solutions of sodium perchlorate in perchloric acid at 20°C, was found to be equal to $2.46 \times 10^{25}$ and the resulting salt solubility product was $7.8 \times 10^{-32}$. (tr-auth)

**28846** APPLICATION OF ALKYLAMMONIUM SALTS FOR THE DISSOLUTION OF INORGANIC COMPOUNDS. III. DISSOLUTION OF THE CRYSTAL HYDRATES $UF_4 \cdot nH_2O$ IN SOLUTIONS OF TRIDECYLAMMONIUM FLUORIDE. Lipovskii, A. A.; Nikitina, S. A. Radiokhimiya, 11: 44-51(1969). (In Russian).

The dissolution of crystal hydrates, $UF_4 \cdot nH_2O$, in solutions of tridecylammonium fluoride was studied. Dissolution was facilitated by the presence of water, which induces reconstruction of the lattice to the cubic form. The solubility of the uranium(IV) reaches 280 g U/l. Uranium can be extracted from organic solutions in the form of solid precipitates containing U(IV). For the transfer of uranium in solution its previous oxidation in the organic phase up to U(VI) is necessary. The composition of the complex compound of the U(IV) in the organic phase was established by measurement of the electronic and infrared spectra. In dilute solutions of nonpolar solvents the structure of the complex anion $UF_6^{2-}$ was distorted by hydrogen bonding to the incorporated ionic water vapor. This deformation did not occur in polar solvents. A premise is expressed concerning the causes of the absence of higher fluoride complexes of uranium in the system studied. (tr-auth)

**28847** THE APPLICATION OF ALKYLAMMONIUM SALTS FOR DISSOLUTION OF INORGANIC COMPOUNDS. V. ABSORPTION SPECTRA AND STRUCTURE OF COMPLEX COMPOUNDS FORMED ON DISSOLUTION OF $UO_2C_2O_4.3H_2O$ IN SOLUTIONS OF TETRADECYLAMMONIUM OXALATE IN $CCl_4$. Kuzina, M. G.; Lipovskii, A. A. Radiokhimiya, 11: 91-4(1969). (In Russian).

Complex compounds, obtained on dissolution of $UO_2C_2O_4 \cdot 3H_2O$ in solutions of tetradecylammonium oxalate, were studied. On treatment of solid uranyl oxalate by the solution a gradual dis-

solution of the crystals occurred. In the process of dissolution samples of the organic solution were selected and analyzed. Successive changes in the spectrophotometric characteristics of organic solutions of uranyl oxalate are given in a table. Studies of the spectra showed that the oxalate groups are coordinated to atoms of uranium. Formation of a dimeric complex compound was not observed. (M.C.G.)

**28848** THERMODYNAMIC SECONDARY DEUTERIUM ISOTOPE EFFECT IN THE THERMAL REARRANGEMENT OF BIALLYL. Maljocic, R.; Humski, K.; Borcic, S.; Sunko, D. E. (Rudjer Boskovic Inst., Zagreb). Univ. of Zagreb). Tetrahedron Lett., No. 25, 2003-6 (May 1969).

The deuterium isotope effect was measured in the degenerate Cope rearrangement of biallyl-1,1,6,6-$d_4$ and biallyl-3,3,4,-$4d_4$. Values are given for the temperature range 25 to 220°C. The value of 1.41 at 25°C represented a free energy difference of 204 cal/mole. Results are discussed. (UK)

**28849** TRACER STUDY OF STEREOSPECIFIC BUTADIENE POLYMERIZATION INITIATED BY Rh CATALYST IN WATER EMULSION. Sokolov, V. N.; Babitskii, B. D.; Kormer, V. A.; Poddubnyi, I. Ya.; Chesnokova, N. N. (All-Union Synthetic Rubber Research Inst., Leningrad). J. Polym. Sci., Part C, No. 16, 4345-50(1969).

From IUPAC Meeting on Macromolecular Chemistry, Prague. See CONF-650801-(Pt.8).

Stereospecific polymerization of butadiene with different rhodium compounds in water medium has been studied using the tracer method. Water is shown to play an active part in both the initiation and termination stages as evidenced by the presence of $-\overset{\backslash}{\underset{/}{C}}-OH^3$ and $-\overset{\backslash}{\underset{/}{C}}-H^3$ groups in polymers. The $OH^-$, $Cl^-$ polar groups of the polymer were found to be allylic. It has been shown for the case of rhodium acetate complex, using the kinetic isotope effect method that termination of polymer chains occurs through water proton addition. A coordinated mechanism through π-allylic complexes has been proposed for the polymerization of butadiene with rhodium catalysts. It has been assumed that the initiation is a π-allylic complex forming reaction, propagation of polymer chains occurring through the monomer molecules introduction between a metal atom and organic ligand. (auth)

**28850** PREPARATION OF PLUTONIUM. Ramsey, William J.; Jepson, James O.; Wood, David H. (to United States Atomic Energy Commission). U. S. Patent 3,442,642. May 6, 1969.

A method is described for the preparation of plutonium by reacting dicesium plutonium hexachloride ($Cs_2PuCl_6$) with lithium. (AEC)

**28851** PRECIPITATION AND HYDROLYSIS OF URANIUM (VI) IN AQUEOUS SOLUTIONS. VI. INVESTIGATION ON THE PRECIPITATION OF AMMONIUM URANATES. Tomazic, B.; Samarzija, M.; Branica, M. (Ruder Boskovic Inst., Zagreb). J. Inorg. Nucl. Chem., 31: 1771-82 (June 1969).

The precipitation boundary was studied in the aqueous system $UO_2(NO_3)_2-NH_4OH-NH_4NO_3$. Assuming that the first precipitation product is ammonium heptauranate, the solubility product constant was estimated to be $\log K_{s1.25} = -14.3$. A mechanism for the formation of ammonium uranates from alkaline solutions is proposed, assuming the presence of anionic uranyl hydroxo-complexes. The morphology of precipitates isolated from alkaline solutions is described. (auth) (UK)

**28852** HIGHER OXIDATION STATES OF AMERICIUM IN PHOSPHATE SOLUTIONS. Yanir, E. (Soreq Nuclear Research Centre, Yavne, Israel); Givon, M.; Marcus, Y. Inorg. Nucl. Chem. Lett., 5: 369-72 (May 1969).

Success in preparing the Am(IV) state at comparable concentrations and stabilities in phosphoric acid and alkali pyrophosphate solutions is reported. The (VI) state was also obtained, under selected conditions. Details of the electrolytic preparation methods are given. It was also found possible to replace the usual method of dissolving $Am(OH)_4$ by a convenient electrolytic oxidation method. At 5M $H_3PO_4$ Am(VI) resulted exclusively, reducing spontaneously with a half-time of ~12 hr. Above this concentration Am(IV) resulted with increasing yield up to ~12M $H_3PO_4$. At still higher $H_3PO_4$ concentrations solutions were very viscous and electrolysis was not efficient. The half-time for spontaneous reduction of Am(IV) to Am(III) was >3 hr, and no disproportionation was apparent. The absorption spectra are reproduced. In a solution containing ~3M $NH_4F$, 2M $K_4P_2O_7$, and 0.3M $H_3PO_4$, Am(IV) was found to be very stable, reducing only by 5% in 7 hr, and reduction was much less than in 3M fluoride solution without pyrophosphate. Although it was expected that dialkylphosphoric acids would stabilize Am(IV), direct dissolution produced solutions containing only Am(VI) and (III). Am(V) could be stabilized in iodate solutions, although stabilization of Am(IV) was expected. Electrolytic oxidation in 2M $LiIO_3-0.7M$ $HIO_3$ produced nearly pure Am(V). (UK)

**28853** CO-PRECIPITATION OF Hf(IV), Zr(IV), Sn(IV), AND W(VI) WITH TITANIUM 8-HYDROXYQUINOLATE. Qaim, S. M.; Ejaz, M. (Atomic Energy Centre, Lahore). J. Inorg. Nucl. Chem., 31: 1737-41 (June 1969).

The coprecipitation behavior of $^{175}Hf(IV)$, $^{95}Zr(IV)$, $^{113}Sn(IV)$, and $^{181}W(VI)$ with titanium 8-hydroxyquinolate was investigated. True coprecipitation occurred only for zirconium and tungsten. Results were interpreted in terms of relative solubilities and chemical compositions of the complexes. (auth) (UK)

**28854** ISOTOPE EXCHANGE PROCESS. (to Houilleres du Bassin du Nord et du Pas-de-Calais). British Patent 1,150,405. Apr. 30, 1969. Priority date Aug. 16, 1966, France.

A process is described for enriching liquid $NH_3$ with D in two exchangers in series with the liquid $NH_3$ in the first exchanger being contacted with the synthesis gases and in the second exchanger with the products of cracking of some of the enriched $NH_3$. The temperature in the second exchanger is maintained 10 to 100°C higher than that in the first exchanger so that the exchange reaction proceeds toward the production of $NH_2D$. The D-enriched liquid $NH_3$ from the second exchanger is evaporated to provide a vaporized portion, some of the vapor is cracked and returned to the second exchanger, and the liquid portion containing a catalyst for the exchange reaction is recycled to the first exchanger. The synthesis gas coming from the first exchanger is passed to a synthesis unit from which at least a part of the liquid $NH_3$ produced is supplied to the first exchanger. The synthesis gas coming from the second exchanger, together with fresh synthesis gases, is passed to the first exchanger. (B.L.M.)

**28855** MEASUREMENT OF THE MOLECULAR g VALUES IN $H_2O$ AND $D_2O$ AND HYPERFINE STRUCTURE IN $H_2O$. Kukolich, Stephen G. (Univ. of Illinois, Urbana). J. Chem. Phys., 50: 3751-5 (May 1, 1969).

Individual components of the Zeeman transitions in the rotational spectrum of $H_2O$ and $D_2O$ were resolved in fields of 25 to 30 kG. This allowed determination of the g values with greater accuracy than previous measurements. The g values obtained for $H_2O$ were $g(5_{23}) = 0.6959 \pm 0.001$ and $g(6_{16}) = 0.6565 \pm 0.001$. The g values obtained for $D_2O$ were $g_{aa} = 0.3233 \pm 0.001$, $g_{bb} = 0.3580 \pm 0.001$, and $g_{cc} = 0.3226 \pm 0.001$. Analysis of the combined results indicates that the g values for $H_2O$ are positive and that the values are $g_{aa} = 0.6650 \pm 0.002$, $g_{bb} = 0.7145 \pm 0.002$, and $g_{cc} = 0.6465 \pm 0.002$. Hyperfine structure on the $6_{16}$ to $5_{23}$ transition in $H_2O$ was observed in a maser spectrometer, and the spin-rotation and spin-spin coupling constants were obtained. The measured value of the rotational transition frequency was 22,235,079.85 ± 0.05 kHz. The magnetic susceptibility anisotropies and molecular quadrupole moments were determined in $H_2O$. (auth)

**28856** COMPOSITION AND STRUCTURE OF AMMONIUM URANATES. Stuart, W. I.; Whateley, T. L. (Australian Atomic Energy Commission, Lucas Heights). J. Inorg. Nucl. Chem., 31: 1639-47 (June 1969).

The composition and structure of the ammonium uranates were investigated by ir spectrophotometry and thermal analysis. Ammonia was present in all the uranates as the $NH_4^+$ ion. In an aqueous environment incorporation of ammonia into the solid occurred by a cation exchange mechanism, and ammonium uranates were therefore regarded as cation-exchanged modifications of the parent $UO_3 \cdot 2\,H_2O$ (i.e., $UO_2(OH)_2 \cdot H_2O$). The asymmetric stretching frequency of the uranyl ion decreased with increasing $NH_4^+$ content. This decrease was continuous and no band splitting was observed, indicating that the ammonium uranate system is homogeneous and continuous. (auth) (UK)

**28857** PLUTONYL-MONOCHLOROACETATE COMPLEXES IN AQUEOUS SOLUTION. Cassol, A.; Portanova, R.; Magon, L. (CNR, Padua). Inorg. Nucl. Chem. Lett., 5: 341-6 (May 1969).

Studies were made on the formation, in aqueous solution, of plutonyl-monochloroacetate complexes, which were carried out by determining the concentration of the free ligand by means of potentiometric $[H^+]$ measurements. All measurements were made at a temperature of 20 ± 0.1°C and in a perchlorate medium of ionic strength I = 1 M. The results suggest that the stability of the complexes increases with increasing pK of the corresponding acid. (P.C.H.)

**28858** STARK EFFECT AND ELECTRIC DIPOLE MOMENT OF $D_2Se$. Mirri, A. M.; Corbelli, G.; Forti, P. (Univ., Bologna). J. Chem. Phys., 50: 4118 (May 1, 1969).

The Stark effect in rotational transitions of $D_2Se$ was studied. Measurements were made on the Stark components of two lines, the $J = 2_{02} \rightarrow 2_{11}$ at 170,211.30 Mc/sec and the $J = 6_{42} \rightarrow 6_{51}$ at 160,591.79 Mc/sec. (J.G.B.)

**28859** THE INFLUENCE OF VAPOUR PRESSURE ON THE FORMATION OF ANHYDROUS ZIRCONIUM SULPHATES. Bear, I. J. (Commonwealth Scientific and Industrial Research Organization, Melbourne). Aust. J. Chem., 22: 875-89(May 1969).

The anhydrous products resulting from the dehydration of $Zr(SO_4)_2 \cdot 4H_2O$ in external atmospheres of controlled $H_2SO_4$ and $SO_3$ partial pressures consist of three polymorphs, two of which, $\gamma$- and $\beta$-$Zr(SO_4)_2$, are metastable and equilibrate to the stable phase, $\alpha$-$Zr(SO_4)_2$. The rates of decomposition of these anhydrous sulfates to cubic $ZrO_2$ have been measured and activation energies for the processes calculated. From these data the vapor pressure-temperature diagram for the anhydrous region of the $ZrO_2-SO_3-H_2O$ system has been delineated. This shows that the existence range of $\gamma$-$Zr(SO_4)_2$ lies within that of $\beta$-$Zr(SO_4)_2$ while both lie within that of the stable $\alpha$-phase. The function of physical factors, such as particle and sample size and heating technique, in controlling phase formation during dehydration in air is interpreted in terms of the vapor pressure-temperature diagram. (UK)

**28860** ELECTRIC CONDUCTIVITIES OF FUSED SALT MIXTURES CONTAINING UCl, KCl, AND NaCl. Mochinaga, Junichi; Cho, Kangjo (Tokyo Inst. of Tech.). Denki Kagaku, 37: 280-3(Apr. 1969). (In Japanese).

In order to investigate some fundamental properties of electrolytes for the electropurification of U, and of fuels for a fused salt fast reactor, the electric specific conductivities of $KCl-UCl_3$, $KCl-NaCl$ (em) $-UCl_3$, and $NaCl-UCl_3$ systems were measured, and the constants for an empirical Kohlrausch equation were calculated on a HITAC 5020 computer, by the least squares method. Some of the curves plotting specific electric conductances against temperature showed a tendency for conductivities to decrease at high temperatures. The separation of some melts into 2 phases at the surface was observed during the measurements, and the decrease in conductivity appeared to be due to this separation. (NSA of Japan)

**28861** PROTON MAGNETIC RESONANCE STUDIES OF EDTA COMPLEXES OF LANTHANIDES. Siddall, T. H.; Stewart, W. E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Inorg. Nucl. Chem. Lett., 5: 421-5(May 1969).

Preliminary PMR investigations of EDTA complexes of La, Ce, Nd, Pr, and Sm (as their sodium salts-NaLnEDTA) are reported, and measurements of their relative stability constants were made. The structure of the compounds was also studied. The complexes of the four paramagnetic lanthanides (Ce, Nd, Pr, and Sm) all show a single AB quartet for the methylene protons ($-CH_2CO$) and a singlet for the ethylene protons ($>N-CH_2-CH_2-N<$). The lanthanum-EDTA complex shows a singlet for each of these kinds of protons, presumably because the field gradient is too small in this diamagnetic complex to make the protons in a methylene group observable nonequivalent at 60 Mc. PMR data for 0.3M solutions in $D_2O$ at 80°C are also given and discussed in relation to structure of the complexes. (auth) (UK)

**28862** HYPERFINE STRUCTURE OF HDO, $D_2O$, AND HDSe BY BEAM MASER SPECTROSCOPY. Bluyssen, Henricus Johannes Antonius. Nijmegen, Netherlands, Katholieke Univ., 1968. 92p.

Thesis.

Studies were made on the hyperfine structure of some rotational transitions in the deuterated water-like molecules HDO, $D_2O$, and HDSe. Application of beam modulation and phase sensitive detection resulted in a greatly improved sensitivity, which allowed detection of very weak transitions. From the measured hyperfine spectra the values for the electric field gradient at the deuteron and the spin-rotation coupling tensor at the proton and the deuteron were determined. (P.C.H.)

**28863** ON THE EXISTENCE OF CERIUM MONOCARBIDE: CERIUM NITRIDE CARBIDES. Anderson, J. S.; Clark, N. J.; McColm, I. J. (Oxford Univ.). J. Inorg. Nucl. Chem., 31: 1621-37(June 1969).

Reexamination of the binary system Ce-C gave no evidence for the existence of any phase structurally based on monatomic (methanide) anions, but the $C_2^{2-}$ anions of $Ce_2C_3$ appeared to undergo reversible dissociation to mathanide anions at high temperatures (1800 to 2000°C). The ternary system Ce-C-N is complex. Both tetragonal $CeC_2$ and bcc $Ce_2C_3$ showed evidence of substitutional replacement of $C_2^{2-}$ by $N^{3-}$, with a significant composition range in the ternary diagram; their hydrolysis conformed to the pure acetylide type. One, and probably two, fcc nitride carbides of variable composition were found: a nitride carbide Ce $N_xC_y$ ($x + y \geq 0.8$; $0.4 < x < 0.7$; $y < 0.4$) in apparent equilibrium with the $Ce_2C_3$ phase, which furnished $CH_4$ as a primary hydrolysis product, and was regarded as a defect structure derived from CeN by partial substitution of $C_1$ anionic units; (b) in the absence of the $Ce_2C_3$ phase a fcc nitride carbide Ce $N_xC_y$ with $x + y \geq 1$, which yielded $C_2$ hydrocarbons and must be regarded as of "acetylide" type. Structural problems and the mechanism of reactions leading to the formation of nitride carbides are discussed. (auth) (UK)

**28864** REACTIVE SCATTERING OF K BY HBr, DBr IN CROSSED MOLECULAR BEAMS: ANGULAR AND VELOCITY DISTRIBUTIONS OF KBr IN LABORATORY AND c.m. SYSTEMS. Gillen, Keith T.; Riley, Clyde; Bernstein, R. B. (Univ. of Wisconsin, Madison). J. Chem. Phys., 50: 4019-33(May 1, 1969).

Measurements of the velocity and angular distribution of KBr formed in reactive collisions between crossed molecular beams of velocity-selected K and thermal HBr(DBr) at a collision energy of 2.8 kcal/mole are described. The results were subjected to a computer analysis to extract information about the center-of-mass (cm) distributions. For both isotopic systems, the cm recoil energy distributions are broad, and are similar in shape. The cm angular distributions are also broad; HBr shows relatively greater wide-angle scattering than DBr. The total reactive cross section for K + HBr is 40% larger than that for K + DBr. Measurements of the angular distribution of nonreactively scattered K agree well with the results of Airey, et al., in the region of the rainbow angle. (auth)

**28865** HYDROGEN-DEUTERIUM EXCHANGE OF BOVINE PLASMA ALBUMIN. Bryan, William P.; Nielsen, Sigurd O. (Danish Atomic Energy Research Establishment, Risoe). Biochemistry, 8: 2572-9(June 1969).

An improved method for studying deuterium exchange of proteins dissolved in $D_2O$ was developed. Certain errors inherent in the original Linderstrøm-Lang method were minimized and some of the experimental techniques made simpler by use of quantitative infrared analysis for the determination of small amounts of $D_2O$ in $H_2O$. The method was applied to a study of the N-F isomerization of bovine plasma albumin. Exchange curves have been obtained in the pD region 2.6 to 5.9. Analysis of the results leads to a picture of the N-F isomerization in which both N and F forms have two regions of slowly exchanging hydrogens. When isomerization of an N form occurs, the more rapidly exchanging region grows at the expense of the more slowly exchanging region. From the pD dependence of the exchange kinetics it can be concluded that the rates of exchange in the isomerization region are determined by the rates of transconformational openings of protein structure. These results support the microheterogeneity model of Foster, et al., (1965) (Foster, J. F., Sogami, M., Peterson, H. A., and Leonard, W. J. (1965), J. Biol. Chem., 240: 2495). (auth)

**28866** MATRIX INFRARED SPECTRUM AND BONDING IN THE DIBROMOMETHYL RADICAL. Carver, T. Granville; Andrews, Lester (Univ. of Virginia, Charlottesville). J. Chem. Phys., 50: 4223-34(May 15, 1969).

Simultaneous condensation of bromoform and lithium atoms at high dilution in argon on a CsI window at 15°K produces new infrared absorptions which are assigned to lithium bromide and the dibromomethyl radical. The identity of dibromomethyl is confirmed by comparison of spectra obtained from $HCBr_3$, $DCBr_3$, and $HCBr_2Cl$ precursors reacting with lithium and sodium. These new absorptions are assigned to the antisymmetric H-C-Br bending and C-Br stretching modes and the symmetric C-Br vibration. The antisymmetric vibrational assignments are supported by product-rule and normal-coordinate calculations which give the potential constants $F_{55} = 3.10 \pm 0.10$ mdyn/Å, $F_{56} = 0.32 \pm 0.01$ mdyn/rad, and $F_{66} = 0.50 \pm 0.05$ mdyn · Å/rad$^2$, while the symmetric C-Br mode yields an approximate force constant $F_{22} = 3.7 \pm 0.4$ mdyn/Å. The C-Br valence force constants for bromomethyl radicals exceed normal C-Br values, while electronic stabilization for these radicals is indicated by bond dissociation energies. Similar results for chloromethyl radicals, in contrast to fluoromethyl radicals, suggest that (p-d)$\pi$ bonding between the free-radical carbon orbital and the d orbitals on chlorine and bromine might account for the stabilization of chloromethyl and bromomethyl radicals, which cannot occur for fluoromethyl radicals or molecules with completely satisfied valence. (auth)

**28867** MATRIX INFRARED SPECTRUM AND BONDING IN THE DICHLOROMETHYL RADICAL. Carver, T. Granville; Andrews, Lester (Univ. of Virginia, Charlottesville). J. Chem. Phys., 50: 4235-45(May 15, 1969).

Simultaneous deposition of chloroform and lithium atoms at high

dilution in argon on a CsI window at 15°K produces new infrared absorptions which are attributed to lithium chloride and the dichloromethyl radical. The identity of dichloromethyl is provided by comparison of spectra recorded after reactions of $HCCl_3$, $DCCl_3$, and $HCCl_2Br$ with lithium and sodium and the detection of $(HCCl_2)_2$ following diffusion and the decrease in $HCCl_2$ absorptions. The new absorptions are assigned to the antisymmetric H−C−Cl bending and C−Cl stretching vibrations. These vibrational assignments are supported by product-rule and normal-coordinate calculations which give the potential constants $F_{ss} = 3.60 \pm 0.10$ mdyn/Å, $F_{ss'} = 0.35 \pm 0.01$ mdyn/rad, and $F_{ss} = 0.56 \pm 0.05$ mdyn · Å/rad². The carbon−chlorine valence force constant deduced here exceeds normal C−Cl values, while bond dissociation energies indicate that $HCCl_2$ is electronically stabilized. Similar results for bromomethyl radicals, in contrast to fluoromethyl radicals, suggest that (p-d)π bonding between the free-radical carbon orbital and the d orbitals on chlorine and bromine may account for the stabilization of chloromethyl and bromomethyl radicals, which cannot occur for fluoromethyl radicals or molecules with completely satisfied valence. (auth)

# Radiation and Nuclear Chemistry

*Refer also to abstracts 28772, 28935, 29236, 29251, 29345, 29379, 29382, and 30618.*

**28868** (AD-683534) INVESTIGATION OF THE EFFECT OF GAMMA-RADIATION ON THE PROCESS OF OXIDATION OF POLYETHYLENE AS DETERMINED BY INFRARED SPECTROSCOPY. Narzullaev, B. N.; Korodenko, G. D.; Karimov, S. N.; Marupov, P. Translated by D. Koolbeck from Dokl. Akad. Nauk Tadzh. SSR, 10: No. 3, 21-4(1967). 10p. (FTD-HT-23-1103-68). CFSTI.

Polyethylene, 100 microns thick, was irradiated using a $^{60}Co$ source to a dose of $10^5$ to $4 \times 10^8$ power RADS. The sample was kept under vacuum for 20 days and exposed to the air for 5 days. The ir spectrum was determined and analyzed, and graphical representations illustrating the dependence of the optical density of the bands at 1720, 1465, 1375, and 965/cm on the dose are illustrated. A mechanism to account for the processes of degradation and loss of crystallinity is suggested. (auth)

**28869** (AERE-R-6040) THE IRRADIATION OF CARBON DIOXIDE CONTAINING SMALL AMOUNTS OF METHANE: THE FORMATION OF HYDROGEN. Hearne, J. A.; Hummel, R. W. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). Feb. 1969. 33p. Dep. CFSTI. UK 5s. 0d.

Carbon dioxide at atmospheric pressure and containing 2000 VPM methane, methane-$d_4$, or their equimolar mixture, with or without the addition of 1% carbon monoxide or 200 VPM oxygen, was irradiated with $^{60}Co$ γ radiation over the temperature range 20 to 400°C. G-values for $H_2$, HD, and $D_2$ are reported, and possible reactions are discussed. Hydrogen is formed predominantly via H-atom reactions; formation by elimination of molecular $H_2$ from $CH_4$ is negligible. Energy transfer from excited $CO_2$ species to CO is postulated, in competition with transfer to $CH_4$. The latter appears to be temperature dependent. (auth) (UK)

**28870** (BMwF-FBK-69-11) FLASH PHOTOLYSIS AND PULSE RADIOLYSIS IN RADIATION BIOLOGICAL RESEARCH. Niemann, E.-G. (Technische Hochschule, Hanover (West Germany). Institut fuer Strahlenbiologie). Apr. 1969. 102p. (In German). Dep.

Possibilities and limitations of flash photolysis and pulse radiolysis techniques in the investigation of primary processes in biological systems are discussed. The design of two flash light sources, an x-ray flash equipment, and a new method of kinetic absorption spectroscopy is described in detail, which is especially adapted to the investigation of radiation biological problems. The final discussion concerns some open questions in the reaction kinetics of biological systems and investigates the possibility of their solution by means of flash photolysis and pulse radiolysis. (auth)

**28871** (JPRS-48117) EFFECT OF IONIZING RADIATION ON AMMONIUM PERCHLORATE-BASE FUEL COMBUSTION. Strunin, V. A.; Manelis, G. B.; Ponomarev, A. N.; Tal'roze, B. L. Translated from Fizika Goreniya Vzryva, 4: 585-90(1968). 9p. CFSTI.

Experiments on the combustion of ammonium perchlorate and mixtures of ammonium perchlorate with fuels were conducted with preirradiated material and under conditions of irradiation of the combustion zone directly during the burning of the specimens. Studies were made on the effects of ionizing radiation with different penetrating capability: x rays, fast electron beam, and glow discharge plasmas. The greatest effect was obtained in a glow discharge plasma. If the entire crystal bulk was subjected to irradiation with fast electrons and x rays, the combustion rate remained practically unchanged. A reduction of the effect of irradiation with reduction of the ammonium perchlorate particle size was apparently associated with the increase of the role of the natural defects in the finely dispersed powder in comparison with the defects that arise with irradiation. The results were significant in indicating the important role of the kinetics of ammonium perchlorate decomposition for the process of the combustion of mixture-type compositions. (P.C.H.)

**28872** γ-RADIOLYSIS OF DISULFIDES IN AQUEOUS SOLUTION. II. D-PENICILLAMINE DISULFIDE. Purdie, J. W. (Defence Research Board, Ottawa). Can. J. Phys., 47: 1029-36 (Mar. 15, 1969).

The γ radiolysis of D-penicillamine disulfide (PenSSPen) in $3 \times 10^{-4}$ M aqueous solution has been studied under aerated and deaerated conditions. G-values were determined for the following products: penicillamine sulfinic acid ($PenSO_2H$), penicillaminic acid ($PenSO_3H$), β-hydroxyvaline (PenOH), 2-amino-3-methylbut-3-enoic acid ($HOOC \cdot CH(NH_2) \cdot C(CH_3)=CH_2$), penicillamine (PenSH), penicillamine disulfide-S-monoxide (PenS(O)SPen), valine (PenH), penicillamine trisulfide (PenSSSPen), and ammonia. The low yield of $PenSO_3H$ in aerated solutions indicated that PenSOH did not react with oxygen of $O_2^-$. The trisulfide, which was obtained in high yield, was found to come mainly from the reactions: PenSSPen + ·OH → PenSSOH + Pen and PenSSOH + PenSH → PenSSSPen + $H_2O$. Experiments with ·OH radicals produced chemically ($TiCl_3/H_2O_2$) and irradiations with cysteine or penicillamine present were used to confirm these reactions. These and the other reactions were tested with radical scavengers; formate and monochloroacetate ions and nitrous oxide. (auth) (CANADA)

**28873** METHOD FOR PRODUCING A POROUS BODY BY THE RADIOPOLYMERIZATION OF A WATER-SOLUBLE MONOMER. Shinohara, Yasuo (to Toyo Rayon Co.). Japanese Patent 1969-1987, Jan. 28, 1969. Filed Mar. 12, 1965.

A method is proposed by which a porous body can easily be obtained that may be used for heat-insulation, cushion, etc. An aqueous solution of a water-soluble monomer capable of polymerization is foamed, and the foamed solution is irradiated with ionizing radiation, to obtain the desired polymerization. The polymerized solution, which is in the form of a porous gel, is then dried, to give the porous body. The foaming is done either by stirring or by introducing a gas; as the viscosity-increasing agent, a water-soluble high-polymer may be used. In the solution of a monomer, other additives such as dyes can be used. (NSA of Japan)

**28874** METHOD FOR PRODUCING A PORES-PRODUCING RESIN OF THE POLYSTYRENE SYSTEM. Yoshitake, Toshihiko (to Kurashiki Rayon Co.). Japanese Patent 1969-3829, Feb. 17, 1969. Filed Jan. 11, 1965.

A method is proposed for producing a pores-producing resin of the polystyrene system that has the following advantages: the graft polymerization of a conjugated diene-system monomer (or its mixture with a vinyl monomer) with the resin, results in high flexibility and toughness and the remaining monomer can be utilized after graft polymerization as a pores-initiating agent. A resin of the polystyrene system in the form of powder is first irradiated with ionizing radiation. Then, the irradiated powder is brought in contact with a conjugated diene-system monomer, or its mixture with a vinyl monomer capable of radical copolymerization with the monomer; alternatively, either of the two can be in solution with a solvent, the powder introduced in the solution so as not to lose its form. The reaction is stopped before the monomer is completely consumed in the graft polymerization. In the product obtained, containing the graft-polymerized rubber-form component, the unreacted monomer is employed as the pores-initiating agent. (NSA of Japan)

**28875** METHOD FOR PRODUCING A CONDENSATION DIMER OF CYCLOHEXANONE. Yumoto, Takaari (to Chief of the Agency of Industry, Science, and Technology). Japanese Patent 1969-2707, Feb. 4, 1969. Filed Dec. 23, 1965.

A method is proposed employing radiation by which a condensation dimer of cyclohexanone can be produced with a high yield; the applications of the dimer are being developed, especially as an agricultural chemical. A chlorinated hydrocarbon such as tetrachloroethylene, carbon tetrachloride, or dichloromethane is added to cyclohexanone, as its solvent. The solution is then irradiated with high-energy radiation like x rays, to obtain the condensation of its dimer. The solvents can be used singly or in their mixture. The condensation reaction can proceed at

ordinary temperature; but, with an increase of the temperature, the period of the reaction can be reduced. (NSA of Japan)

**28876** METHOD OF GRAFT-POLYMERIZATION. Sugimoto, Kenichi (to Kurashiki Rayon Co.). Japanese Patent 1969-2230, Jan. 30, 1969. Filed Nov. 19, 1964.

A method is proposed for graft-polymerizing a copolymer whose main constituent is vinyl chloride or poly(vinyl chloride), and a compound of the vinyl or diene system, employing ionizing radiation. A copolymer, containing vinyl chloride or poly(vinyl chloride) as the main constituent, in the form of grains or powder, is first irradiated with ionizing radiation. The irradiated powder is then immersed in a methanol solution of a compound of either the vinyl or diene system, to obtain the desired graft-polymerization. The obtained polymer, having a grafting ratio of 10 to 40%, is again irradiated with ionizing radiation, in an atmosphere of either air or an inert gas. The irradiated powder is immersed, in a methanol solution of the compound of the vinyl or the diene system. The temperature of the graft polymerization may be −20° to 100°C. (NSA of Japan)

**28877** RADIATION COPOLYMERIZATION OF OLIGO GLYCOL MALEATE MODIFIED BY CYCLOPENTADIENE. Omelchenko, S. I.; Videnina, N. G.; Chervetsova, I. N. (Inst. of Chemistry of High Molecular, Kiev. Inst. of Physical Chemistry, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B, No. 1, 32-5(Jan. 1969). (In Ukrainian).

The radioinduced copolymerization of oligoglycomaleate, modified by cyclopentadiene, with different monomers (styrene, methyl methacrylate, vinyl acetate, triallyl cyanurate, and triallyl isocyanurate) was investigated. The properties of the copolymers obtained were compared with those of analogous thermochemical samples. The results showed that radiation improved the properties of the copolymers. (auth)

**28878** A LABORATORY STUDY OF FLAME-RETARDANT TEXTILES PRODUCED BY AN IONIZING RADIATION CURE. Miles, T. D.; Delasanta, A. C. (Army Natick Labs., Mass.). Text. Res. J., 39: 357-62(Apr. 1969).

Methods for polymerizing triallyl phosphate on a cotton fabric were examined under conditions feasible for application in a commercial radiation textile finishing process. Although triallyl phosphate does not polymerize with irradiation at low dose levels at room temperature in air under the specific conditions described, it was found that copolymerization of triallyl phosphate with acrylic acid derivatives can be used to produce flame-resistant cotton fabric. A cotton fabric treated with triallyl phosphate and N-methylol acrylamide and exposed to 2 megarads of radiation from high-energy electrons, in air at room temperature produced a flame-resistant fabric durable to 15 accelerated cotton mobile launderings. (auth)

**28879** THE PREPARATION AND CHARACTERIZATION OF SOME CELLULOSE GRAFT COPOLYMERS. V. ESR STUDY OF PREIRRADIATION GRAFTING OF STYRENE TO CELLULOSE ACETATE. Campbell, D.; Williams, J. L.; Stannett, V. (Research Triangle Inst., Research Triangle Park, N. C.). J. Polym. Sci., Part A-1, 7: 429-37(Feb. 1969).

Previous studies have shown a two-peak molecular weight distribution of the grafted polystyrene side chains from preirradiation-grafted cellulose acetate. ESR was used to investigate this grafting system in further detail. It was found that the rate of decay of the trapped radicals on adding the monomer solution was quite slow and a substantial proportion remained after 3 days at 25°C. The G value for radicals lost was, however, in good agreement with the G (grafted side chains) produced during the same period. The ESR spectrum does not change on addition of the monomer solution. The explanation offered is that the side chains grow and terminate rapidly compared with the slow overall rate of decay. The grafting yield and the molecular weight of the grafted side chains continue to grow until the reaction is terminated, leading perhaps to the high molecular weight narrow distribution fraction. (auth)

**28880** RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF METHYL N-VINYLCARBAMATE. Woo, James T. K.; Kochanny, G. L. Jr.; Loy, B. R.; Nowak, R. M. (Dow Chemical Co., Midland, Mich.). J. Polym. Sci., Part B, 7: 181-4(Mar. 1969).

The γ-radioinduced polymerization of solid state methyl N-vinylcarbamate at −78 and 25°C to a total dose of 5 Mrads yielded 5.0 and 94.0% polymerization. Further experiments disclosed extensive post-irradiation polymerization at ambient temperature. ESR studies confirmed the presence of free radicals. Two possible stereo structures are presented. (J.G.B.)

**28881** γ-RAY INDUCED COPOLYMERIZATION OF ETHYLENE AND VINYL CHLORIDE IN LIQUID CARBON DIOXIDE. Hagiwara, Miyuki; Miura, Takeshi; Kagiya, Tsutomu (Japan Atomic Energy Research Inst., Gunma). J. Polym. Sci., Part A-1, 7: 513-23(Feb. 1969).

The γ-ray-induced copolymerization of ethylene and vinyl chloride with the use of liquid carbon dioxide as a solvent was studied under a total pressure of 400 kg/cm², with a dose rate of $2.5 \times 10^4$ RAD/hr at 30°C. A rubberlike, sticky polymer is obtained when the molar concentration of vinyl chloride is less than 30% in the monomer mixture, and the polymer is a white powder at higher concentrations of vinyl chloride. Infrared, x-ray, and differential thermal analyses confirm that the polymerization products are noncrystalline, true random copolymers. The rate of copolymerization decreases markedly when a small amount of vinyl chloride is added to ethylene monomer. In the range of vinyl chloride concentration higher than 5%, however, the rate and the molecular weight of copolymer increase with increasing concentration of vinyl chloride. It was concluded from kinetic considerations based on these results that the rate of initiation increases proportionally with the concentration of vinyl chloride. Further, the growing chain radicals are shown to be deactivated by the cross-termination reaction between the radicals with terminal unit of ethylene and vinyl chloride, and no transfer reaction occurs. (auth)

**28882** POLYMERIZATION OF AROMATIC ALDEHYDES. II. CATIONIC CYCLOPOLYMERIZATION OF PHTHALALDEHYDE. Aso, Chuji; Tagami, Sanae; Kunitake, Toyoki (Kyushu Univ., Fukuoka). J. Polym. Sci., Part A-1, 7: 497-511(Feb. 1969).

Phthalaldehyde was found to undergo cyclopolymerization with ease by several cationic catalysts and by γ-ray irradiation. The polymer was composed entirely of the dioxyphthalan unit, as confirmed by infrared spectroscopy and ready decomposition to monomer. The enhanced polymerizability of phthalaldehyde as compared with other aromatic aldehydes was explained in terms of the intermediate-type or, preferably, concerted propagation scheme. The conversion reached a saturation value of 87% in about 1 hr in methylene chloride at −78°C, indicating an equilibrium polymerization. The ceiling temperature of the polymerization was −43°C, as estimated from the relation between the saturation yield and polymerization temperature. The enthalpy and entropy of propagation were −5.3 kcal/mole and −23.0 eu, respectively. Since the molecular weight of the polymer was proportional to conversion, the propagating chain end was considered to be "living" in this system. The rate constant for propagation was calculated to be 0.18 l/mole-sec in methylene chloride at −78°C with $BF_3OEt_2$ catalyst. (auth)

**28883** IDENTIFICATION OF PRODUCTS FORMED BY RADIOINDUCED OXIDATION OF 1-HEPTENE. Sydykova, D. S.; Markova, Z. A.; Saraeva, V. V. Vestn. Mosk. Univ., Ser. II. Khim., No. 2, 33-8(Mar.-Apr. 1969). (In Russian).

Infrared spectroscopy and gas-liquid chromatography were used for the identification of products formed by γ-radioinduced oxidation of 1-heptene. 1-Heptene-3-ol, 2-heptene-1-ol, 1-heptene-3-one, and 2-heptenal were identified. (auth)

**28884** A SIMPLE GENERATOR FOR THE SEPARATION OF RADIOACTIVE DAUGHTER PRODUCTS. Colonomos, M.; Parker, W.; Perez-Alarcon, I. (Instituto Venozolano de Investigationes Cientificas, Caracas). Atompraxis, 15: 114-15(Mar.-Apr. 1969).

A simple, single operation-generator for the separation of radioactive daughter products is described. The device is of stainless steel construction and includes two bacteriological filters. When charged and assembled the generator is fitted between the plunger portion of a hypodermic syringe and the syringe needle. In this particular instance the generator was tested using the system $^{99}Mo-^{99m}Tc$ but can obviously be employed with any other radioactive pair. The principal advantage of the described generator is the instantaneous elution of the daughter activity for medical or nonmedical application. (auth)

**28885** CROSSLINKING OF POLYETHYLENE OXIDE IN SOLUTIONS BY THE ACTION OF $^{60}Co$ γ RADIATION. Schnabel, Wolfram; Borgwardt, Uwe (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Makromol. Chem., 123: 73-9(1969). (In German).

Polyethylene oxide is crosslinked by $^{60}Co$ γ-rays above the critical concentrations in methanol and in aqueous solution. In dilute aqueous solution crosslinking is mainly due to the indirect effect, in methanol, however, to the direct action of radiation on the polymer. Below the critical concentration microgels are formed in water, whereas in methanol the polymer is preferentially degraded in the main chain. At 80°C polyethylene oxide crosslinks somewhat more rapidly in concentrated aqueous solutions than at room temperature. However, the critical concentration for gelation is 25 times higher than at room temperature. Below the critical concentration microgels are formed at 80°C. The transition from

intermolecular crosslinking to microgel formation at a relatively high polymer concentration is attributed to the contraction of the coils at 80°C, which has been proved by light scattering measurements. (auth)

**28886** REACTION OF IODINE IN THE NEUTRON IRRADIATION OF IODOBENZENE. Peacocke, T. A. H. (St. John's School, Leatherhead, Eng.); Walton, G. N. J. Chem. Soc., A, No. 8, 1264-71(1969).

Measurements are reported on the amount of molecular iodine, labeled with $^{131}I$, that is retained in the organic form when iodobenzene is irradiated with thermal neutrons in the graphite reflector of a reactor, and with γ-rays from a $^{60}Co$ source. It is shown that internal conversion and electronic processes associated with the (n,γ) reaction and its products are more efficient, by an order of magnitude, in promoting the chemical effects, than gamma-ray absorption. (auth) (UK)

**28887** KINETIC BEHAVIOR OF $HO_2$ RADICALS AND THEIR ACID FORM WITH RESPECT TO FERROUS AND FERRIC IONS. Pucheault, Jacques; Ferradini, Christiane; Buu, Antoinette (Institut de Physique Nucleaire, Pairs). Int. J. Radiat. Phys. Chem., 1: 209-18(Apr. 1969). (In French).

Results from the radiolysis of the system Fe(II)/Fe(III) in presence of air and sulfuric or perchloric acid indicated an apparent influence of pH on the oxidation and reduction rates in this system by the $HO_2$ radical. It was concluded that this effect is due to the existence of an acid form of the radical $HO_2$: $HO_2 + H^+ \underset{k_4}{\overset{k_3}{\rightleftharpoons}} H_2O_2^+$, which oxidizes ferrous ions: $H_2O_2^+ + Fe^{2+} \xrightarrow{k_{1b}} Fe(III) + H_2O_2$, while $HO_2$ reduces the different forms of the ferric ion: $HO_2 + Fe(III) \xrightarrow{k_2} Fe^{2+} + H^+O_2$. The ratios of the corresponding rate constants were found to be $k_4/k_{1b} = 1.6 \times 10^{-3}$ mole/l, $k_2/k_3 = 1.20$ for the sulfuric acid medium. (auth) (UK)

**28888** THERMOLUMINESCENCE OF $ZrO_2$. Bettinali, C.; Ferraresso, G.; Manconi, J. W. (Univ., Rome). J. Chem. Phys., 50: 3957-61(May 1, 1969).

The thermoluminescence of $ZrO_2$ samples, both pure and doped with titanium, irradiated with low doses of x rays has been studied. The glow curve of $ZrO_2$(Ti) exhibits, in the temperature range 100 to 350°K, four main peaks all having the same spectral composition. The pure $ZrO_2$ presents a similar glow curve but having a luminous intensity about $2 \times 10^3$ times lower than that of the doped material. These data indicate that $Ti^{4+}$ ions act as thermoluminescent centers. Activation energies were calculated by means of the initial rise method and also by using the shape of the isolated peaks. The electron traps probably are related to oxygen vacancies. In fact, the luminous intensity increases when the vacancy concentration increases, and the activation energies calculated from the dielectric constant are close to the activation energies obtained from glow peak data. The build-up curves indicate that the vacancies, acting as trapping centers, exist prior to the irradiation and are probably of the same type for all of the thermoluminescent peaks. (auth)

**28889** CHOICE OF OPTIMUM CONDITIONS FOR ISOTOPE PRODUCTION BY IRRADIATION. Zaritskaya, T. S.; Rudik, A. P. At. Energ. (USSR), 26: 432-6(May 1969). (In Russian).

Pontryagin's maximum principle was applied to find the optimum conditions for isotope production by irradiation. Only three types of isotope production are found to be principally possible: irradiation in maximum neutron flux, irradiation in a neutron flux determined by the classical laws of calculus of variations, and time exposure of a sample irradiated in a reactor. The optimum conditions are found for the irradiation in maximum neutron flux. An example is given of determining time function of neutron flux, determined by the classical laws of calculus of variations. (auth)

**28890** FORMATION OF THIN FILMS FROM BIS-(METHYLALLYL)-BIS-(DIMETHYL)-CYCLOTETRASILOXANE [DIALLYLHEXAMETHYLCYCLOTETRASILOXANE] BY ELECTRON BOMBARDMENT. Kolotyrkin, V. M.; Butaev, A. M.; Tsapuk, A. K.; Tunitskii, N. N. Khim. Vys. Energ., 3: 71-3(Jan.-Feb. 1969). (In Russian).

Thin polymer films were formed on metallic surfaces by electron irradiation of bis-(methylallyl)-bis-(dimethyl)-cyclotetrasiloxane [diallylhexamethylcyclotetrasiloxane] in the presence of water vapor. The rate of formation of the films was studied with respect to the irradiation time, water vapor pressure, and the current densities. The dielectric characteristics of the films were evaluated. (tr-auth)

**28891** PHOTOINDUCED CONVERSIONS OF FREE RADICALS IN POLYMERS. I. ALLYL AND POLYENE RADICALS IN γ-IRRADIATED POLYPROPYLENE. Klinshpont, E. R.; Milinchuk, V. K.; Pshezhetskii, S. Ya. Khim. Vys. Energ., 3: 74-80(Jan.-Feb. 1969). (In Russian).

The kinetics of the photoinduced conversion of allyl and polyene radicals in the alkylation in γ-irradiated polypropylene was studied by electron paramagnetic resonance. The reversible conversion of allyl radicals between 77 and 180°K is described by an equation of the first order. At temperatures greater than 190°K besides the conversion of allyl and polyene radicals in the alkylation, their recombination under the action of light was also observed, the kinetics of which is described by an equation of the second order. (tr-auth)

**28892** INVESTIGATION OF IRRADIATED POLYMERS BY OPTICAL SPECTROSCOPY AND ELECTRON PARAMAGNETIC RESONANCE. I. POLYPROPYLENE. Klinshpont, E. R.; Milinchuk, V. K. Khim. Vys. Energ., 3: 81-7(Jan.-Feb. 1969). (In Russian).

Electron paramagnetic resonance and ultraviolet spectroscopy were used to study polypropylene irradiated at 77 to 330°K. From analysis of the spectra it was concluded that allyl radicals were formed by γ irradiation in liquid nitrogen. The yield of allyl radicals depends on the degree of crystallinity of the polymer. The bands of allyl radicals (255 nm), dienes (240 nm), trienes (295 nm), and the corresponding polyene radicals were identified in the absorption spectra. It was assumed that the absorption bands with maxima of 220 and 270 nm were due to the allyl anion and cation. (tr-auth)

**28893** RADIATION TRANSFORMATIONS AND DOSIMETRIC PARAMETERS OF POLYSTYRENE FILMS CONTAINING LUMINESCENT DYES. Generalova, V. V.; Vainshtok, B. A.; Levchenko, N. F. Khim. Vys. Energ., 3: 90-1(Jan.-Feb. 1969). (In Russian).

A study of the relation of radiation dose to optical absorption intensity (range 280 to 420 mm) and luminescence intensity (400 to 600 mm) of polystyrene films was studied by adding luminescent dyes [1,2-(1',8'-naphthoylene)benzimidazole or its derivatives]. The radiations used were $^{60}Co$ γ radiation, α particles from $^{238}Pu$ and 405 mμ light. The luminescence intensity decreased with an increase of dose significantly faster than the optical absorption intensity. The absorption spectra and luminescence were not otherwise changed. From calculations and experimentation it was established that the main contribution to the reduction of luminescence was from quenching due to products from polymer oxidation. (D.H.M.)

**28894** FORMATION OF PEROXIDE RADICALS IN LIQUID HYDROCARBONS IN THE PRESENCE OF MOLECULAR OXYGEN DURING PULSE RADIOLYSIS. Bakh, N. A.; Zimina, G. M. Khim. Vys. Energ., 3: 92-3(Jan.-Feb. 1969). (In Russian).

The presence of molecular oxygen in concentration of $10^{-2}$ mole/g in hydrocarbons was found to be connected to short-lived particle absorption in the uv spectra from 2400 to 3200 A, however, in vacuum this absorption was not observed. Two absorption maxima were observed in n-heptane ($\lambda$ = 2550 A and $\lambda$ = 2700 A) and in 1-heptane one maximum ($\lambda$ = 2700 A) was observed (T = 300°K). The kinetics of extinction of the particle with absorption maximum $\lambda$ = 2700 A followed the law of second order and was the same in n-heptane and 1-heptene. Spectrophotometric and electron paramagnetic resonance studies identified the particle as the peroxide radical. (D.H.M.)

**28895** RADIOLYSIS OF n-ALKYL KETONES. Ermakova, G. A.; Larin, V. A.; Revina, A. A.; Bakh, N. A. Khim. Vys. Energ., 3: 94-5(Jan.-Feb. 1969). (In Russian).

Electron paramagnetic resonances and gas–liquid chromatography were used to study the pulse and γ radiolysis of the methyl ketones from methyl ethyl ketone to methyl hexyl ketone and the symmetrical dialkyl ketones from diethyl ketone to dipentyl ketone. The γ irradiation was conducted at 24 to 26°C in a dose range of $10^{17}$ to $10^{20}$ eV/g with a dose rate of 1 to $3 \times 10^{16}$ eV/g sec. The effects of acceptors on the yields was used to study the radiolysis mechanisms. (D.H.M.)

**28896** MORPHOLOGY AND STRUCTURE OF POLYMER CRYSTALS. Sauer, J. A. (Rutgers-The State Univ., New Brunswick, N. J.). Ann. N. Y. Acad. Sci., 155: 517-38(Jan. 27, 1969).

From Polymer Science, Current Concepts and Civic Applications Conference, New York, N. Y. See CONF-670516.

A review is presented on the effects of various variables on the morphology and structure of polymers. These include polymer composition, crystallization conditions, electron radiation, high temperature annealing, and deformation. The crystal structure and perfection affected by radiation is due most probably to crosslinking; the degree of crystal perfection is rapidly lost at high electron beam doses. (P.C.H.)

**28897** GAMMA RADIATION-INDUCED IONIC VINYL POLYMERIZATION. Metz, Donald J. (Brookhaven National Lab., Upton, N. Y.); Ballantine, David S. Ann. N. Y. Acad. Sci., 155: 468-81(Jan. 27, 1969).

From Polymer Science, Current Concepts and Civic Applications Conference, New York, N. Y. See CONF-670516.

A review is presented on the radioinduced ionic polymerization of liquid vinyl monomers, which has been found to be feasible despite the low dielectric constant of the medium. Qualitatively radioinduced ionic polymerization has been established to occur in the following monomers: styrene, α-methylstyrene, isobutene, isobutyl vinyl ether, cyclopentadiene, α- and β-pinene, nitroethylene, and liquid trioxane. The effects of sample preparation, dose rate, molecular weight, and inhibitors on radioinduced ionic polymerization are discussed. (P.C.H.)

**28898** POLYMER SCIENCE: CURRENT CONCEPTS AND CIVIC APPLICATIONS. Conference Held in New York, May 9, 10, and 11, 1967. Krauss, Marc (ed.). Ann. N. Y. Acad. Sci., 155: 383-656(Jan. 27, 1969). (CONF-670516).

Eighteen papers are included; separate abstracts were prepared for two. The remaining 16 papers contain information on: cation radicals in polymer synthesis; nature of growing species in anionic polymerization; copolymerization of isobutene with butadiene and isoprene; esterolytic activities of copolymers containing imidazole groups; stereospecific polymerization of olefins; microtacticity; noncovalent interactions in solution; polymers in dilute solution; mechanical properties of crystalline polymers interpreted in terms of dislocations; conductive polymers; optical studies of polymer films; polymer science in the prevention of air pollution and water pollution; role of polymers in the automotive industry; and use of polymer science in telecommunications and building construction. (P.C.H.)

*For abstracts of individual papers see: 28896 and 28897.*

**28899** INVESTIGATION OF THE MECHANISM OF THE RADIOLYSIS OF PIPERIDINE. Podsoblyaev, A. P. Khim. Vys. Energ., 3: 54-60(Jan.-Feb. 1969). (In Russian).

In order to establish the mechanism for the formation of hydrogen and other products in the radiolysis of piperidine, the influence of temperature and additions on the radiation yields was studied and an attempt was made to establish their relation to the intermediate products of the radiolysis. An increase in the temperature produced an increase in the yield of hydrogen from condensation, which resulted in the dissociation of excited molecules of piperidine with the formation of H atoms and α-piperidyl radicals. The activation energy of the process is equal to 0.45 kcal/mole. The process for the formation of molecular hydrogen depended only slightly on the irradiation temperature. The formation of molecular hydrogen with a yield of 1.1 was observed to be independent of the acceptor. The disappearance of paramagnetic particles and the formation of hydrogen, tetrahydropyridine, and piperidine hydroperoxide are related processes. The formation of one hydrogen molecule is accompanied by the disappearance of two paramagnetic particles. It is assumed that at 77°K paramagnetic particles are stabilized basically by the cation radicals of piperidine and by electron capture by piperidine molecules. (tr-auth)

**28900** RADIOLYSIS OF GASES IN ELECTRIC FIELDS. II. THE EFFECTS OF ELECTRIC FIELD ON THE RATE OF DEUTERIUM–HYDROGEN EXCHANGE. Larin, I. K.; Tal'roze, V. L.; Kulazhenkova, N. A. Khim. Vys. Energ., 3: 14-16(Jan.-Feb. 1969). (In Russian).

The effects of electric field on the rate of deuterium–hydrogen exchange in the system $H_2-D_2$ during radiolysis was studied. Results show that upon the utilization of an electric field sufficient for the saturation of ionic current, the yield of HD molecules decreases 2 to 5 times, and this agrees with theoretical calculations of the effects of electric field on the mean lifetime of ions in ionization chambers. (tr-auth)

**28901** EFFECT OF CATION VACANCIES ON RADIOLYSIS OF SODIUM NITRATE. Kaucic, S.; Maddock, A. G. (Chemical Labs., Cambridge, Eng.). Trans. Faraday Soc., 65: 1083-90 (Apr. 1969).

Doping sodium nitrate crystals by homogeneous incorporation of calcium nitrate increased $G_{-NO_3^-}$ for radiolytic decomposition. The proportions of radiolytic decomposition products did not appear to be much affected, but the maximum concentration of radical species (other than $NO_2$·) surviving at room temperature was substantially larger than in the untreated sodium nitrate. (auth) (UK)

**28902** THE THERMAL STABILITY OF γ-IRRADIATED STRONTIUM AZIDE. Prout, E. G.; Moore, D. J. (Univ. of Cape Town). J. Inorg. Nucl. Chem., 31: 1595-1607(June 1969).

The thermal stability of solid strontium azide was found to be considerably reduced by pre-irradiation with γ rays ($^{60}Co$). The isothermal decomposition of the unirradiated salt was followed by measuring the pressure of gas evolved in a constant-volume system. It was characterized by a pronounced induction period, which was followed by an acceleratory period, which then passed into decay. The sigmoid pressure-time plots in the temperature range 120 to 150°C are described by the power law, $p^{\frac{1}{3}} = k_2t + c_2$ in the acceleratory period, and by the contracting-sphere formula $(1-\alpha)^{\frac{1}{3}} = k_3t + c_3$ in the decay period. Pre-irradiation of the salt by γ rays drastically reduced the induction period and increased the velocity constants. The power law was obeyed up to doses of $10^5$ Rad, and the exponential law $\log p = k_1t + c_1$ for γ doses greater than $2.5 \times 10^5$ Rad. Between these doses neither equation fit. The activation energies for the processes during the induction period, acceleratory and decay periods were approximately the same (average 23.3 ± 1.5 kcal $mole^{-1}$) and were almost unchanged by preirradiation. It was not possible to detonate the salt in the γ source, but by suitable treatment of the irradiated salt with water vapor the salt became highly explosive. A study of the effects of water vapor at various stages of the decomposition establishing the significant role which strontium metal plays in the decomposition of both the irradiated and unirradiated salt. A theoretical explanation of the decomposition mechanism of the unirradiated and irradiated salts, involving the formation of strontium metal and the interaction of positive holes and excited azide ions, is presented. It is suggested that pre-irradiation by γ rays produces a high concentration of vacancies in the salt, and that these are responsible for the drastic changes in the subsequent thermal decomposition. (auth) (UK)

**28903** RADIOLYSIS OF AQUEOUS SOLUTIONS OF BENZENE IN THE PRESENCE OF TRANSITION METAL IONS. II. THE RADIOLYTIC TRANSFORMATIONS IN 0.4 M SULFURIC ACID SOLUTION CONTAINING FERROUS IONS AND OXYGEN AT HIGH DOSE RATES. Kartasheva, L. I.; Pikaev, A. K. Khim. Vys. Energ., 3: 10-13(Jan.-Feb. 1969). (In Russian).

The radiolysis of solutions of benzene in 0.4 M $H_2SO_4$ containing $Fe^{2+}$ ions and oxygen was studied at dose rates of $10^{21}$ to $10^{23}$ eV/ml·sec created by single pulses of $5 \times 10^{-6}$ sec duration. It was discovered that the radiation yields of phenol, muconaldehyde, and $Fe^{3+}$ ions were significantly below the yields obtained upon γ irradiation at dose rates of $4 \times 10^{13}$ to $10^{16}$ eV/ml·sec and that they decreased with an increase of dose rate from $1.4 \times 10^{21}$ to $8 \times 10^{22}$ eV/ml·sec. It was concluded that in addition to the reactions that occur upon γ radiolysis at high dose rates there also proceeds the recombination of the radicals $O_2C_6H_6OH$ and $HO_2$ as well as the reaction of $O_2C_6H_6OH$ with $HO_2$. (tr-auth)

**28904** RADIATION-CROSSLINKED POLYPROPYLENE: PHYSICAL AND DIELECTRIC PROPERTIES. Benderly, Asaf A. (Harry Diamond Labs., Washington, D. C.); Bernstein, Bruce S. J. Appl. Polym. Sci., 13: 505-17(Mar. 1969).

Irradiation of two stereoregular polypropylenes and a polyallomer via $^{60}Co$ in the presence of 3 to 8% allyl methacrylate (AMA) monomer, to doses up to 5 MRad, lead to an improvement in mechanical properties. With irradiation, heat resistance, tensile strength, and gel fractions increased, and creep compliance was revealed by measurements of irradiated samples at 185°C (at constant load and monomer level), a temperature above the $T_m$ of polypropylene. Dielectric properties (dielectric constant K and dissipation factor tan δ) were virtually unaffected by irradiation of 0.3 to 5.0 MRad in nitrogen when AMA was absent. In the presence of monomer, small but generally tolerable increases in tan δ resulted if the monomer concentration was not too great. To obtain improvements in mechanical properties while not simultaneously altering the dielectric losses, it was necessary to keep the AMA concentration to a maximum of 4%. (auth)

**28905** RADIOLYSIS OF METHANE IN THE PRESENCE OF ISOBUTYLENE. Collin, Guy J.; Herman, Jan Alexander (Univ. Laval, Quebec). J. Chim. Phys., 66: 496-500(Mar. 1969). (In French).

The effects of isobutylene on the radiolysis of methane were compared to that of methanol and ammonia. The isobutylene acts as a very efficient scavenger of free radicals and therefore protects the formation of ethylene from methane. The ethyl ions react with isobutylene preferentially by proton transfer. The tertiobutyl ions do not form isobutane by hydride-ion transfer, nor do they decompose into propene. (auth)

**28906** PHYSICOCHEMICAL ACTION OF FAST ELECTRONS ON POWDERED MIXTURES OF SELENIUM AND A METAL.

Belin, Esther; Bonnelle, Christiane; Delafosse, Denise (Laboratoire de Chimie Physique, Paris. Laboratoire de Recherches sur la Reactivite des Solides, Dijon, France). Compt. Rend., Ser. C, 268: 1288-91(Apr. 9, 1969). (In French).

Some powdered mixtures of selenium–copper, selenium–nickel, and selenium–iron were irradiated by electrons with an energy of 10 to 50 keV. After irradiation, various selenium-containing phases were observed. Their formation was attributed to the ionizing action of the electron beam. (tr-auth)

**28907** A STUDY BY THE METHOD OF INFRARED SPECTROSCOPY OF THE RADIATION STABILITY OF A SERIES OF VINYL AROMATIC POLYMERS AND COPOLYMERS. Gunder, O. A.; Koba, V. S. Radiokhimiya, 11: 119-22(1969). (In Russian).

The objects of investigation were pure polymers, polystyrene (PS), polyvinyldiphenyl (PVD), and polyvinylnaphthalene (PVN), copolymers of styrene with vinyldiphenyl and vinylnaphthalene, and solid solutions of diphenyl and naphthalene in polystyrene. The materials were subjected to photons and to gamma radiation. It was established that the radiation stability of the polymers increases in the series PS < PVN < PVD. The copolymerization of styrene with vinylaromatic monomers increased the stability of the latter to radiation. The most stable polymer was the copolymer of styrene with vinyldiphenyl. The differences in the behavior of the aromatic compounds on their introduction into the chain of the polymer and the formation of solid solutions were determined. (M.C.G.)

**28908** THE SURFACE STRUCTURE OF RADIOACTIVE CRYSTALS OF Ba, Sr, AND Ca SULFATES. Gromov, V. V.; Spitsyn, Vikt. I. Radiokhimiya, 11: 89-91(1969). (In Russian).

Electron microscopy was used to study the surface structure of the radioactive crystalline precipitates $BaSO_4$, $SrSO_4$, and $CaSO_4 \cdot 2H_2O$. In all cases the surfaces of radioactive forms were more nonhomogeneous than those of nonradioactive forms. It was established that radiation has an effect on the structure of the precipitates studied in the moment of their formation and increase. Calcination smooths the heterogeneities of the surfaces of radioactive preparations. (tr-auth)

**28909** TEXTILE POLYMERS: EFFECTS AND APPLICATION OF NUCLEAR RADIATION. Rochast, P. (Centre de Recherches de la Soierie et des Industries Textiles, Lyon). Isotop. Radiat. Technol., 6: 404-10(Summer 1969).

The literature is reviewed on the effects of nuclear radiation on natural and man-made fibers and the means by which this radiation may be used to impart new properties to such fibers by radiation grafting. (43 references) (auth)

**28910** GENERATORS OF $^{90}Y$ AND $^{140}La$. Mikheev, N. B. Radiokhimiya, 11: 126-7(1969). (In Russian).

The radioactive isotopes $^{90}Y$ and $^{140}La$ are formed as a result of the beta decay of the parent isotopes $^{90}Sr$ and $^{140}Ba$. By using these chains of radioactive decay it is possible to prepare generators of $^{90}Y$ and $^{140}La$. Aluminum oxide was used as a sorbent. Elution of radioisotopes from the generators is realized using tributyl phosphate and nitric acid. Yields of not less than 90% with a purity of 99.9% were achieved. (M.C.G.)

**28911** CHEMICAL EFFECTS OF NUCLEAR REACTIONS IN MIXED CRYSTALS. IV. CHEMICAL EFFECTS OF THE $^{187}Re(\gamma,n)^{186}Re$ NUCLEAR REACTION IN $K_2ReBr_6$–$K_2SnCl_6$ MIXED CRYSTALS. Mueller, Horst (Univ., Freiburg, i.B.). J. Inorg. Nucl. Chem., 31: 1579-93(June 1969). (In German).

The nuclear reaction $^{187}Re(\gamma,n)^{186}Re$ was carried out in homogeneous mixed crystals $K_2ReBr_6$–$K_2SnCl_6$ by irradiation with energetic $\gamma$ quanta ($E \leq 60$ MeV). After dissolution of the irradiated crystals the $^{186}Re$ activity was found in the form of the mixed hexabromochlororhenates $^{186}ReBr_nCl_{6-n}^-$ ($0 \leq n \leq 6$) and the Szilard–Chalmers yield $^{186}ReO_4^-$. The separation was accomplished by ionophoresis and ionic exchange on diethylaminoethylcellulose paper, respectively. Due to the large recoil range of ca 100 Å the recoil rhenium atoms leave the environment of their six original bromine ligands; the mixed halogenorhenates are produced in nearly the amounts expected statistically. The differences are explained by a slight preference of the recoiling atom for chlorine in favor of bromine during the back reaction in the solid. The primary retention is zero. The studies refute the models proposed by Libby: billiard-ball impact; and recoil of rhenium atoms accompanied by part of their ligands. The existence of micro domains (clusters) of differing analytical composition was excluded and the true homogeneity of the mixed crystals was confirmed. By thermal annealing, part of the perrhenate yield was transformed into hexahalogenorhenates. (auth) (UK)

**28912** RADIATION EFFECTS IN COLLAGEN: A QUANTITATIVE ELECTRON SPIN RESONANCE STUDY. ten Bosch, Jacobus Johannes Utrecht, Univ. of Utrecht, 1967. 136p. Thesis.

Collagen from rat tail tendon was modified in several different ways to obtain 4 triple helix materials (t.h.) with different degrees of ordering and 6 random coil materials (r.c.) with different molecular weights. These were irradiated in vacuum in the dry state. Electron spin resonance spectra were the same for all materials, the G-values for radical production were increasing with from 1.7 to 5.3 with molecular ordering (t.h.) and decreasing from 3.9 to 1.4 with molecular weight (r.c.). The kinetics of several models of radical reactions were investigated theoretically to determine their value for explaining observed radical concentration–dose curves. The experimental results are explained on the basis of a radiation-induced free radical turnover process combined with fast delocalization process in the t.h. materials. Similar measurements on glycine peptides did not show correlation with the collagen results, probably due to crystallization effects. All errors involved in the determination of free radical concentration with the ESR method were investigated in special experiments and calculations. Systematical errors due to power saturation, shape and size of the sample, and spectra evaluation are the most important. General recommendations for determining and decreasing the errors from each source are given. (auth)

**28913** ELECTRON SPIN RESONANCE STUDIES OF RADICAL PAIRS FORMED IN HYDROXYUREA BY X IRRADIATION AT LOW TEMPERATURES. Reiss, Keith; Shields, Howard (Wake Forest Univ., Winston-Salem, N. C.). J. Chem. Phys., 50: 4368-72 (May 15, 1969).

Radical pairs were identified in single crystals of hydroxyurea x irradiated at 5, 30, and 77°K. There are two chemically identical but magnetically nonequivalent pairs present and at least one other weak pair. The main pairs have an average separation between the unpaired spins of 6.38 Å, and the radicals of the pairs are located in adjacent molecular layers. A separation of $R \leq 5.3$ Å was measured for the weak pair. The magnetically nonequivalent pairs were identified as $NH_2CONHO \ldots OHNOCH_2N$. Each radical has the same structure as the stable room-temperature radical. Decay of the main radical pairs with R = 6.38 Å into isolated radicals is exponential and follows a first-order rate law giving an activation energy of 0.4 eV per molecule. (auth)

**28914** ELECTRON SPIN RESONANCE OF A SIGMA-ELECTRON RADICAL IN X-RAY-IRRADIATED MALONAMIDE. Cyr, N.; Lin, W. C. (Univ. of British Columbia, Vancouver). J. Chem. Phys., 50: 3701-6(May 1, 1969).

Two radical species were formed when malonamide crystals were irradiated with x ray. One was a $\pi$-electron radical of common occurrence, $NH_2COCHCONH_2$, and the other was interpreted as a $\sigma$-electron radical of the formula $NH_2COCH_2CONH$. The ESR spectra of the latter were studied in detail and the assignments were substantiated by ESR spectra of deuterated malonamide and $^{15}N$-malonamide. (auth)

**28915** NANOSECOND PULSE RADIOLYSIS AND NONHOMOGENEOUS KINETICS INVOLVING HYDRATED ELECTRONS. Kenney, Geraldine A.; Walker, David C. (Univ. of British Columbia, Vancouver). J. Chem. Phys., 50: 4074-81(May 1, 1969).

Nanosecond pulse-radiolysis studies on the behavior of hydrated electrons at concentrations of about $10^{-4}$ M showed that the decay during approximately the first half-life (~110 nsec) was characterized by a rate constant significantly different from that during the second half-life. The latter rate appeared to follow second-order kinetics. The initial decay is attributed to nonuniform distributions of species and to intratrack reactions involving $e^-_{aq}$ before the system became truly homogeneous. Qualitative calculations on the period of nonhomogeneity were in agreement with the experimental transition time. It is apparent that in some pulse-radiolysis studies one cannot justifiably calculate second-order rate constants from concentrations evaluated from optical-density measurements. The experiments were performed on pure deaerated water subjected to an intense 3-nsec pulse of 0.5 MeV electrons from a Febetron accelerator. Spectrophotometric analyses were conducted over very small reaction volumes by using the 632.8 nm light from a He/Ne laser collimated to 0.07 $mm^2$ cross-sectional area. One possible implication of the fast initial decay is that $G(e^-_{aq})$ is much larger than 2.5. (auth)

**28916** DEPENDENCE OF THE INITIAL RETENTION ON RECOIL ENERGY IN ZINC PHTHALOCYANINE. Yoshihara, Kenji; Yang, Mo-hsiung (Japan Atomic Energy Research Inst., Tokai). Inorg. Nucl. Chem. Lett., 5: 389-92(May 1969).

The effects of recoil energy on initial retentions has not been studied systematically in the hot atom chemistry of solids. There

are different opinions concerning this effect: one stressing the role of the recoil energy and the other stating that charge might be rather important in determining the chemical fate of the recoil atom. In many cases recoil energy has no effect on the initial retentions. Studies are described in which definite dependence of the initial retention on recoil energy in zinc phthalocyanine was found after a systematic investigation of the chemical effects of different types of nuclear transformations. The effects of recoil energy appeared both in $\alpha$- and $\beta$-crystals of the complex. (auth) (UK)

**28917** RADIATION CROSSLINKING OF ALPHA–BETA UNSATURATED PAINT BINDER RESIN. Burlant, William J. (to Ford Motor Co.). U. S. Patent 3,437,514. Apr. 8, 1969. Filed Aug. 2, 1967.

A process is described for providing an exposed external surface of an article of manufacture with a wear- and weather-resistant coating of paint. The film-forming binder of this paint consists essentially of an $\alpha$-$\beta$, olefinically unsaturated organic resin and a monomeric vinyl compound. The resin is characterized by having about 0.5 to about 3.0 $\alpha$-$\beta$ olefinic unsaturation units per 1,000 units molecular weight. The monomeric compound is of lower viscosity than the resin and serves both as a solvent and as a reactant. Thus, the monomer facilitates flow of the binder during application of the film and copolymerizes with the resin when the film is cured. Copolymerization is effected with ionizing radiation at a temperature below the temperature at which significant vaporization of the monomer is initiated to provide when applied to a smooth surface an even film characterized in that distortion of specular reflections from the surface is minimized. (Offic. Gaz.)

**28918** RADIATION CURABLE CYCLIC SILICONE-MODIFIED PAINT BINDERS. Burlant, William J.; Tsou, Ivan H. (to Ford Motor Co.). U. S. Patent 3,437,512. Apr. 8, 1969. Filed Aug. 13, 1965.

A radiation-polymerizable paint binder solution of a polysiloxane-modified organic resin in vinyl monomers is described. The resin has a molecular weight in excess of 1,000, contains about 0.5 to 3 $\alpha$-$\beta$ olefinic unsaturation units/1000 units molecular weight, and is characterized in that at least 10 wt % of the resin is derived from a cyclic siloxane. (Offic. Gaz.)

**28919** RADIATION CURABLE ACYCLIC SILICONE-MODIFIED PAINT BINDERS. Burlant, William J.; Tsou, Ivan H. (to Ford Motor Co.). U. S. Patent 3,437,513. Apr. 8, 1969. Filed Aug. 13, 1965.

A radiation polymerizable paint binder solution of a polysiloxane modified organic resin in vinyl monomers is described. The paint binder resin has a molecular weight in excess of about 1,000, contains about 0.5 to about 3 $\alpha$-$\beta$ olefinic unsaturation units per 1,000 units molecular weight, and is further characterized in that at least 10 wt % is derived from an acyclic siloxane. (Offic. Gaz.)

**28920** RADIATION TREATMENTS IN THE PLASTICS INDUSTRY. INDUSTRIAL APPLICATION OF ELECTRON BEAM ACCELERATORS. Tabata, Yoneho (Tokyo Univ.). Enka Biniiru to Pomria, 8: No. 11, 11-20 (Nov. 1968). (In Japanese).

Industrial processes using radiations are considered. The main fields are crosslinking of plastics, curing of coatings, and wood plastics. Some of the problems related to the industrial applications of electron accelerators in radiation chemistry are reviewed. From the viewpoint of applications, accelerators can be classified into two groups: one is low energy (300 to 500 keV) and high current (10 to 50 mA), and the other is high energy (1 to 2 MeV) and low current (<10 mA). The former is used for curing, and the latter for crosslinking. Accelerators available in the United States are reviewed. Accelerators in the Soviet Russia are also described. The radiation dosage necessary for curing is discussed using the unsaturated polyester–vinyl system as an example. The relationship between plant capacity and the width and speed of the belt conveyor for irradiation is calculated. A few pilot plants for curing reinforced plastics by irradiation are described. Finally, the economy of radiation processes is discussed. Costs are estimated for crosslinking, curing, and grafting. (NSA of Japan)

**28921** RADIATION CURING FOR CASTABLE ELASTOMERS. Sakurada, Ichiro (Doshisha Univ., Kyoto). Kobunshi Kako, 17: 810-11 (Dec. 1968). (In Japanese).

The results reported by Klotz, I.E.C., 7: 165(1968), on the radiation curing of elastomers are reviewed. Liquid prepolymers were obtained from glycerine monolinolate, tolylene diisocyanate, and polypropylene glycol and were cast and cured by $\gamma$ radiation from $^{60}Co$. The resulting elastomer had a long pot-life of more than 2 weeks. The mechanical properties of the elastomers can be widely controlled by the ratio of the unsaturated diol to saturated diol or the ratio of NCO to OH. Thiols were synthesized by the reaction of dithiol with diolefin. The preferable thiol system consists of the reaction products from polytetramethylene ether diol (PTME) bis (mercapto acetate), a small amount of PTME-bis (allyl carbonate), and triallyl cyanurate. It was concluded that while the radiation curing is useful, considerable time and effort must be spent before the process will be of practical use. (TSS) (NSA of Japan)

**28922** IMPROVEMENTS IN OR RELATING TO THE PREPARATION OF OLIGOMERS. (to Commissariat a l'Energie Atomique). British Patent 1,152,561. May 21, 1969. Priority date Jan. 11, 1967, France.

Oligomers were prepared by radioinduced polymerization of heavy olefinic cuts having 5 to 20 carbon atoms at 300 to 350°C. The total radiation dose was $5 \times 10^4$ to $5 \times 10^7$ RAD. After irradiation, the olefinic cut was distilled under vacuum to eliminate the dimer, hydrogenated at 150 to 200°C under pressure, and filtered in the presence of an activated earth at a temperature of 80 to 100°C. (B.L.M.)

**28923** HYDRAZINE FORMATION IN THE $^{10}B(n,\alpha)^7Li$- AND $\gamma$-RADIOLYSIS OF LIQUID AMMONIA [LET- AND PROTECTION EFFECTS]. Stoecklin, G. (Kernforschungsanlage, Juelich, Ger.); Plott, G.; Heckel, E. Int. J. Appl. Radiat. Isotop., 20: 399-411 (June 1969).

The radiolysis of liquid ammonia was studied using the high LET He- and Li-recoil particles from the $^{10}B(n,\alpha)^7Li$ process. Suitable boron compounds such as $H_3NBF_3$ and $B(OC_2H_5)_3$ were dissolved in anhydrous liquid ammonia and irradiated with reactor thermal neutrons. Up to doses of about $10^{21}$ eV/g almost dose-independent $G(N_2H_4)$ values of $1.5 \pm 0.2$ were obtained. Comparison with $\gamma$- and fission fragment radiolysis shows the expected LET-dependence of the hydrazine yield [$\gamma$-radiolysis < $^{10}B(n,\alpha)^7Li$ < $^{235}U(n,f)$]. In the $^{10}B(n,\alpha)^7Li$-radiolysis, however, using 3.2 mole % $H_3NBF_3$ in liquid ammonia the $N_2H_4$-concentration continued to increase at higher doses, a steady-state concentration not being reached, even at $10^{22}$ eV/g. Comparative studies on the $\gamma$-radiolysis of liquid ammonia in the presence of boron compounds indicate that Lewis acids of the type $BX_3$ (X = F, $OC_2H_5$, $C_3H_7$, $C_6H_5$) or their $NH_3$-adducts exhibit strong protection effects against radiation decomposition of the hydrazine formed, thus causing a considerable increase in yield. (auth) (UK)

**28924** RADICALS AND EXCITED STATES IN THE PULSE RADIOLYSIS OF 9,10-ANTHRAQUINONES. Hulme, B. E.; Land, E. J.; Phillips, G. O. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). J. Chem. Soc., D, No. 10, 518-19 (1969).

It was found that semiquinones, OH adducts, and triplet states are formed on radiolysis of anthraquinone solutions. (auth) (UK)

**28925** ENCAPSULATED PROPELLANTS AND METHOD FOR THEIR PREPARATION FROM FLUORINATED MONOMERS USING RADIATION. Woods, Warren W.; Shock, D'Arcy A. (to Continental Oil Co.). U. S. Patent 3,441,455. Apr. 29, 1969. Filed Jan. 13, 1961.

A method of encapsulating at least one solid propellant component in a solid polymeric material in the absence of a polymerization catalyst or crosslinking agent comprises subjecting a mixture of the two components to between $1 \times 10^3$ and $1 \times 10^7$ Rep/hr of $\gamma$ radiation to provide a total dosage of between $1 \times 10^3$ and $1 \times 10^9$ Rep at a temperature between −200 and 200°C. The solid propellant fuel is selected from the group consisting of metals, metal hydrides, and mixed hydrides. The polymerizable monomer is selected from a group consisting of gaseous and liquid monomers or more specifically from a group consisting of ethylenically unsaturated hydrocarbons and halogen, carboxy, and hydroxy derivatives of ethylenically unsaturated hydrocarbons. (Offic. Gaz.)

**28926** DETERMINATION OF THE POLYDISPERSITY IN MOLECULAR MASS AND IN CHEMICAL COMPOSITION OF A GRAFT COPOLYMER OF POLY(ISOBUTYLENE)–POLY(STYRENE) PREPARED BY A RADIOCHEMICAL METHOD. Danon, Jeanne; Jozefowicz, Jacqueline (Laboratorie de Chimie Physique, Orsay, France). J. Polym. Sci., Part C, No. 16, 4523-31 (1969). (In French).

From IUPAC Meeting on Macromolecular Chemistry, Prague. See CONF-650801-(Pt.8).

A graft copolymer of polyisobutylene–polystyrene prepared radiochemically and possessing both a molecular weight polydispersity and chemical heterogeneity has been fractionated by elution on a column. The system solvent–precipitant has been chosen in order to produce a fractionation essentially on the basis of the molecular weight. Some fractions have been examined by light diffusion in order to determine their polydispersities of molecular weight and of chemical composition. It was concluded

that the fractionation was indeed obtained on the basis of molecular weight differences. (auth)

**28927** MECHANISMS OF REINFORCEMENT OF SILICONE RUBBERS CROSSLINKED BY RADIATION. Charlesby, A.; Morris, J.; Montague, P. (Royal Military Coll. of Science, Shrivenham, Eng.). J. Polym. Sci., Part C, No. 16, 4505-13 (1969).

From IUPAC Meeting on Macromolecular Chemistry, Prague. See CONF-650801-(Pt.8).

The tensile strengths and elastic moduli of elastomers can be greatly influenced by the presence of fine particles such as carbon black or silica. This reinforcement can be due to either physical or chemical processes. The use of radiation to provide crosslinks in such systems permits the mechanism of this reinforcement to be studied. The results of some experiments on physical properties, gelation, and swelling behavior for a series of mixtures in dimethylsiloxane polymer are given. An extension to model compounds of low molecular weight allows the chemical bonding effects to be measured in the absence of geometrical inhibition arising from a network structure. (auth)

**28928** CONTRIBUTION TO THE STUDY OF THE RADIOCHEMICAL POLYMERIZATION OF ISOPRENE IN THE SOLID PHASE. Hinschberger, Andre (Centre de Recherches sur les Macromolecules, Strasbourg); Marchal, Jean; Vacherot, Monique; Dworkin, Ary; Roncin, Jean. J. Polym. Sci., Part C, No. 16, 4437-41(1969). (In French).

From IUPAC Meeting on Macromolecular Chemistry, Prague. See CONF-650801-(Pt.8).

The study by calorimetry of the $\gamma$ radioinduced polymerization of isoprene in the solid state showed that the reaction took place through irradiation. No post-effect was observed while heating the polymer from the irradiation temperature to the melting point. Gas chromatography analysis showed that, with respect to the polymer, the proportion of minor products resulting from irradiation was small. After uv irradiation of solid isoprene, the same radical, vinyl 2-allyl, as after $\gamma$ irradiation was found. (auth)

**28929** PULSE RADIOLYSIS OF SULPHUR COMPOUNDS. PART 3. REPAIR BY HYDROGEN TRANSFER OF A MACROMOLECULE IRRADIATED IN AQUEOUS SOLUTION. Adams, G. E. (Mount Vernon Hospital, Northwood, Eng.); Armstrong, R. C.; Charlesby, A.; Michael, B. D.; Willson, R. L. Trans. Faraday Soc., 65: 732-42(Mar. 1969).

Studies of free radical repair by hydrogen transfer from a sulphydryl compound (cysteamine) were extended to a polymeric system. Repair rate constants varied from $2.6 \times 10^7$ $M^{-1}$ $sec^{-1}$ for ethylene glycol to $5 \times 10^6$ $M^{-1}$ $sec^{-1}$ for polyethylene oxide (PEO) of molecular weight 20,000. The analysis of rate data for polymers of mol wt > 200 is complicated by competing radical–radical reactions. A comprehensive reaction scheme is proposed and the kinetic equations solved numerically. The effects of pH and molecular weight on the repair rate were also studied. Some further data on the pulse radiolysis of cysteamine solutions, including a determination of the extinction coefficient of the radical-ion $RSSR^-$ ($\epsilon_{4100} = 9.4 \pm 0.5 \times 10^3$ $M^{-1}$ $cm^{-1}$, are presented. (auth) (UK)

**28930** ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED DICARBOXYLIC ACIDS. Bales, Barney Leroy. Boulder, Colo., Univ. of Colorado, 1968. 86p.

Thesis.

Attempts were made to seek some understanding of the sequence of chemical events leading from primary fragments to stable free radicals in irradiated organic solids. An analysis of the ESR spectra of x-irradiated disodium succinate showed that the radical $^-OOC\dot{C}HCH_3$ is stable at room temperature. This result corrects an error in the previous assignment of the radical $HOOCCH_2\dot{C}H_2$. The $\alpha$-proton principal hyperfine coupling values were 11g, 21g, and 33g, typical values for II-radical $\alpha$-protons. The direction cosines of the principal axes corresponding to the principal values of the $\alpha$-proton hyperfine coupling tensor were used to establish the molecular orientation in a coordinate system defined relative to the features of the crystal habit. The hyperfine tensors corresponding to the three methyl protons were found to be equivalent and axially symmetric indicating a rapid rotation of the group at room temperature. The axial principal value was 24g, while the perpendicular value was 26g. Cooling to 77°K slowed the rotation, but did not stop it completely. Several radicals were observed in oxalic acid irradiated at 77°K and studied at various temperatures. Tentative identification of the radicals has been made consistent with the ESR data, radiolysis yields data, and data obtained in other low temperature work. It has been possible to suggest a radical reaction scheme for the dicarboxylic acids. The process starts with positive and negative ion radicals being the primary products of the radiation damage. Then, the cation radical disappears by transferring a proton across a hydrogen bond to give $HOOC(CH_2)_n\dot{C}O_2$. The reaction following this step depends on the particular system. In malonic acid, $HOOCH_2$ abstracts a hydrogen atom from a neighboring malonic acid molecule giving the well-known radical HOOCCHCOOH with about 50% efficiency at room temperature. In succinic acid, the same process proceeds quite readily, the difference in efficiency being attributed to the greater flexibility of $HOOCCH_2\dot{C}H_2$ due to its increased length. In disodium succinate, a competing process, $^-OOCCH_2\dot{C}H_2 \rightarrow {}^-OO\dot{C}CHCH_3$ predominates. The parallel process $HOOCCH_2\dot{C}H_2 \rightarrow HOO\dot{C}CHCH_3$ occurs in succinic acid also, but with less efficiency. No results indicating the fate of the anion radical in general have been found. In the case of oxalic acid, a new suggestion for the identity of the stable room temperature fragment has been advanced which allows a reasonable reaction scheme to be written. (Disser. Abstr.)

**28931** GAMMA-RADIATION EFFECTS IN SINGLE-CRYSTALLINE BARIUM TITANATE. Keating, John Joseph. Ames, Iowa, Iowa State Univ., 1968. 91p.

Thesis.

The results of an experimental investigation of $^{60}Co$ gamma-radiation effects in single-crystalline barium titanate are presented. Two test groups of crystals were used. One group was etched in phosphoric acid at 145°C prior to being irradiated. The etching process removed from the crystals a surface layer having properties which differ from the bulk of the crystal. The second group of crystals was irradiated in the as-grown condition. Experimental work performed with gamma dose as the variable included development of the ferroelectric hysteresis loop, measurement of the optical absorption spectrum in the wavelength range of 0.43 to 0.70 microns, and the taking of photomicrographs of the domain structure. The irradiation temperature was maintained at 20°C and all post-irradiation measurements were made at 23°C. The etched crystals were irradiated in the poled condition to a maximum dose of $1.60 \times 10^9$ rad. The remanent polarization ($P_r$) was unaffected by a total gamma dose of about $2 \times 10^8$ rad. Irradiation to higher dose levels caused a reduction in $P_r$. The coercive field ($E_c$) was reduced with initial irradiation. At a dose of about $5 \times 10^8$ rad a minimum value was reached and $E_c$ then increased with continued irradiation. The domain structure of the c-domain crystals was unaffected by a total gamma dose of $1.60 \times 10^9$ rad. No absorption peaks were observed in the wavelength range studied as a result of $^{60}Co$ gamma irradiation. The radiation-induced changes observed in the ferroelectric hysteresis loop of etched crystals cannot be attributed to changes in the domain structure or to the presence of point defects consisting of an oxygen vacancy with a single trapped electron. The unetched crystals were irradiated to a maximum dose of $2.91 \times 10^8$ rad. With initial irradiation, the polarization reversal process was enhanced as the remanent polarization increased and the coercive field decreased. With increasing dose above $2 \times 10^7$ rad, the hysteresis loop gradually deteriorated. The unetched crystals were thus found to be much more sensitive to $^{60}Co$ gamma radiation than were the etched crystals. (Disser. Abstr.)

## Radiochemistry

*Refer also to abstracts 28783 and 30018.*

**28932** (MIT-905-133, pp 95-100) HOT ATOM CHEMISTRY GROUP. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science).

The abstraction process for $H-C_4D_{10}$ (n) system was studied at nine different initial laboratory energies between 0.3 and 2.1 eV. In a continuing study of the effects of translationally emitted hydrogen atoms, tritium atoms were reacted with ethylene, acetylene, propylene, 1-butene, 2-butene, isobutene, and trimethylethylene. A study is also being made of the ion molecule reactions (~1 to 50 eV lab) $N_2^+ + D_2O \rightarrow N_2D^+ + OD \rightarrow D_2O^+ + N_2$ and $Ar^+ + H_2 \rightarrow ArH^+ + H$. (D.H.M.)

**28933** GAS–LIQUID CHROMATOGRAPHY OF RADIOACTIVE AMINO ACIDS AS THEIR TRIFLUOROACETYL ESTER DERIVATIVES. Del Favero, A.; Darbre, A.; Waterfield, M. (King's Coll., London. King's Coll. Hospital, London). J. Chromatogr., 40: 213-18(Mar. 25, 1969).

A method is described for the gas chromatography of radioactive amino acids as their trifluoroacetylated ester derivatives. Comparative studies of the methyl, n-butyl, and n-pentyl esters were made. The absolute molar response of the flame ionization detector was calculated for some of the derivatives. (auth)

**28934** STANDARDISATION OF RADIONUCLIDE SOLUTIONS. Sewell, D. K. B. (Commonwealth X-Ray and Radium Lab., Mel-

bourne). Australas. Bull. Med. Phys. Biophys., No. 39, 17-26 (Mar. 1969).

The major methods for standardising radionuclide solutions are described briefly with particular reference to methods for technetium-99m for which a gas flow proportional counter is used for the 2-keV electron and sodium iodide crystal detector for the coincident 140-keV gamma and indium-113m for which a 4 $\pi$ gas flow proportional counter is used for the internal conversion electron. (Australia)

**28935** RUKOVODSTVO K PRAKTICHESKIM ZANYATIYAM PO RADIOKHIMII. (Textbook of Practical Studies in Radiochemistry). Nesmeyanov, An. N. (ed.). Moscow, Izdatel,stvo Khimiya, 1968. 700p.

The concepts of radiochemical and chemical nuclear transformations, chemistry of radioactive elements, and applications of radioisotopes in chemical studies are discussed in detail. Some of the topics included are: radioactive isotopes between liquid and solid phases; ion exchange in radiochromatography; isotopic exchange in dilute solutions; nuclear transformations in chemistry; methods for production of radioactive elements; chemistry and analysis of Th; and chemistry and analysis of products from decay of U, Th, Fr, Pa, Np, and Pu. (381 references). (R.V.J.)

**28936** POSITRONIUM CHEMISTRY IN AQUEOUS $KMnO_4$ SOLUTIONS. Williams, Thomas L.; Ache, Hans J. (Virginia Polytechnic Inst., Blacksburg). J. Chem. Phys., 50: 4493-4501(May 15, 1969).

The reactions of positronium were studied in aqueous $KMnO_4$ solutions at various concentrations and pH. Lifetime measurements showed a distinct decrease of $\tau_2$ and increase of $I_2$ with increasing temperatures, as expected for chemical reactions in which thermalized positronium is involved. No dependence on the pH of the solution could be observed. The activation energy calculated from the temperature dependence of $\tau_2$ is rather small and about 0.1 to 0.2 eV. The free positron annihilation lifetime was found to be approximately 0.55 nsec, which is in good agreement with the value obtained by using Dirac's formula, 0.5 nsec for water. (auth)

**28937** SOME $^{99m}$Tc MEASUREMENTS. Vuorinen, A. (Technical Univ. of Helsinki, Otaniemi, Finland). Ann. Acad. Sci. Fenn., Ser. A VI, No. 311, 1-16(1969).

The principles of the activity measurement of $^{99m}$Tc are reviewed with the main emphasis on proportional counting of conversion electrons in coincidence with fluorescence x rays. The instrumentation and source preparation are briefly described. (auth)

## Separation Processes

*Refer also to abstracts 28680, 28772, 28854, 28860, 29060, 29074, 29106, 29125, 29142, 29143, 29979, 29981, and 29982.*

**28938** (ANL-7524) URANIUM PURIFICATION BY THE PROCESS OF SALT TRANSPORT. Knighton, J. B.; Johnson, I.; Steunenberg, R. K. (Argonne National Lab., Ill.). Mar. 1969. Contract W-31-109-eng-38. 41p. Dep. CFSTI.

An experimental investigation was conducted on the chemical aspects of a salt-transport process for purification of uranium. Separations by means of salt transport are based on the selective transfer of a metallic solute from one liquid alloy to another by the circulation of a molten salt between the two alloys. Distribution-coefficient and solubility measurements were made to provide data needed to select suitable conditions for a uranium salt-transport process. Values are given for the distribution coefficients of uranium between molten $MgCl_2$ or $MgCl_2$-alkali chloride mixtures and the following liquid alloys: Cu-Mg, Cu-Cd-Mg, Cd-Mg, Cd-Zn-Mg, and Zn-Mg. The solubilities of uranium in these liquid alloys are also reported. The advantages and disadvantages of various combinations of alloys and salts for a uranium purification process are discussed. (auth)

**28939** (ARH-SA-26) PLUTONIUM FOR RECOVERY FROM SCRAP AT ATLANTIC RICHFIELD HANFORD COMPANY. Kuklinski, G. B.; Olson, R. E. (Atlantic Richfield Hanford Co., Richland, Wash.). Mar. 24, 1969. Contract AT(45-1)-2130. 17p. (CONF-690411-1). Dep. CFSTI.

From 10th Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nev.

Operating procedures used to receive and convert plutonium-bearing scrap to high-purity plutonium nitrate product are discussed along with procedures to measure or verify, repackage, and store the material. Shipper obligations or responsibilities and receiver handling methods are described. Nuclear Materials Management procedures pertinent to accounting, measurements, and inventory control are outlined. (auth)

**28940** (BMwF-FBK-69-12) SEPARATION OF IODINE IN GASEOUS PHASE BY MEANS OF SEPARATION COLUMNS. Oberhansberg, J. (Technische Hochschule, Darmstadt (West Germany). Eduard-Zintl-Institut). Apr. 1969. 97p. (In German). Dep.

An experimental device was developed to measure the separation of iodine from $CO_2$ and $N_2$ in the range of $10^{-1}$ to $10^{-7}$ g $I_2/m^3$. Decontamination factors (DF) on the order of $10^4$ to $10^5$ were measured using columns loaded with AgCl on silica gel ($AgCl/SiO_2$) or 5 Å Linde molecular sieves or activated charcoal. Higher DF were obtained by increasing the gas flow and the time of contact. In order to achieve high DF values (on the order of $10^4$ to $10^5$) the presence of water is important in case of $AgCl/SiO_2$, whereas the absence of water is important in the case of molecular sieves. Activated charcoal yields high DF values independent of water content. The advantage of $AgCl/SiO_2$ as column material is its high selectivity for iodine. (auth)

**28941** (BNWL-884) PRODUCTION OF HEAVY WATER. Status Report. Ayres, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1969. Contract AT(45-1)-1830. 171p. Dep. CFSTI.

A review is presented on the status of technology in the production of heavy water, and required research and development for heavy water reactors and related systems are identified. Economic considerations, historical symmary of $D_2O$ production in the U.S., and methods for $D_2O$ production, including chemical exchange, distillation, electrolysis, and untested procedures are discussed. (165 references). (P.C.H.)

**28942** (BNWL-tr-28) STUDY OF A STANDARD CHEMICAL (FLOW)-DIAGRAM FOR THE USE OF U(IV) IN THE FIRST PUREX CYCLE, BY MEANS OF COMPLEMENTARY STUDIES IN MIXER-SETTLERS. Salomon, L.; Lopez-Menchero, E.; Ilardi, S. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Translated by E. R. Appleby (Battelle-Northwest, Richland, Wash.), from report NP-17741. 32p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 11604. (TSS)

**28943** (CONF-680810-, pp 249-68) MARINE CHEMICAL RECOVERY. Yee, W. C. (Oak Ridge National Lab., Tenn.).

An economic analysis was made of several possible salt complexes that recover chemicals from the brine discharge of a nuclear desalination plant producing 1000 Mgd of fresh water with a seawater concentration factor of 2. Primary product recovery involves using solar energy at an arid desert site to separate out sequentially gypsum, salt, potash, and magnesium chloride by fractional crystallization. Secondary product production involves using electrical and steam energy from the desalination plant to obtain cement and sulfuric acid, caustic soda and chlorine, and magnesium metal. Caustic soda and chlorine (as hydrochloric acid) can be used to remove bicarbonate ions from seawater prior to fresh-water production. Land requirements for solar evaporation are reduced by the availability of evaporator effluent as a starting material. With 2 × seawater there is a 40% reduction in acreage for the production of solar salt; with 3 × seawater, a 60% reduction. At a 10% cost, the cost of salt production is reduced 15% and 25%, respectively. Utilization of 3% of the brine discharge (2 × seawater) would consume 400 Mw(e) of electric power, would require a capital investment of $84 million, would generate an income of $40 million, and would have a break-even power cost of 5.5 mills/kw-hr at a 10% cost of money. Seawater treatment by the NaOH-HCl method would compete with the conventional sulfuric acid method of treatment at a power cost of 4 mills/kw-hr when sulfur costs $50/ton. (auth)

**28944** (CONF-680810-, pp 269-98) POTABLE WATER FROM SEAWATER BY HIGH-TEMPERATURE ELECTRODIALYSIS. McRae, W. A. (Ionics, Inc., Watertown, Mass.).

Electrodialysis plants that can produce hundreds of millions of gallons daily are considered. The nature of ion-exchange membranes, the process and apparatus, and some of the results obtained at high temperature in the laboratory are discussed. A brief economic analysis of high-temperature electrodialysis plants integrated with large electric power stations is presented. Static tests on membranes at high temperatures show that thermal decomposition of the ion-exchange resin per se will probably not be a serious problem in practical apparatus. The electric resistances of both membranes and saline water are shown to decrease at a compound rate of about 1% per degree Fahrenheit, and current efficiency is found to be essentially invariant with temperature. These findings are confirmed by the operation of laboratory electrodialysis apparatus at 180°F for up to 4 months at the time this paper was written. Costs are estimated for producing 205 Mgd of

fresh water from seawater and from brackish water in high-temperature electrodialysis plants integrated with steam-turbine generators. The estimated total cost of producing fresh water from seawater ranges from $0.44 to $0.46 per thousand gallons. Fresh water from 3000 ppm brackish water is estimated to cost $0.085 per thousand gallons. Research opportunities are outlined, which could reduce the total costs for demineralizing seawater to the range of $0.20 to $0.25 per thousand gallons. (auth)

**28945** (CONF-680810–, pp 299-312) NUCLEAR DESALTING. Burwell, C. C. (Oak Ridge National Lab., Tenn.).

The multistage-flash (MSF) and vertical-tube evaporation (VTE) processes for desalting seawater are discussed briefly. The dual-purpose plant concept is described, and a comparison is made between alternative steam conditions used for the joint production of electricity and water. Previously reported cost projections for energy and desalted water are tabulated and compared with the cost of conveying natural fresh water from a water-rich region. Finally, consideration is given to the potential future application of desalted water to irrigation agriculture. (auth)

**28946** (DOCKET-50201-9) [WEST VALLEY REPROCESSING PLANT]. Provisional Operating License No. CSF-1. (Nuclear Fuel Services, Inc., West Valley, N. Y. New York State Atomic and Space Development Authority, New York). Feb. 27, 1969. 74p. Dep. CFSTI.

Applications are made for transfer of control of Nuclear Fuel Services, Inc., and the AEC licenses and orders governing the operation of NFS from W. R. Grace & Co. to Getty Oil Company. Annual financial reports for 1967 for Skelly Oil Company and Getty Oil Company are included. (M.C.G.)

**28947** (DOCKET-50201-10) [WEST VALLEY REPROCESSING PLANT]. Provisional Operating License No. CSF-1. (Nuclear Fuel Services, Inc., West Valley, N. Y. New York State Atomic and Space Development Authority, New York). Mar. 17, 1969. 7p. Dep. CFSTI.

A request is made for renewal and extension of expiration date of provisional operating license No. CSF-1 to October 19, 1970 for the West Valley Processing Plant. (M.C.G.)

**28948** (DOCKET-50201-11) [WEST VALLEY REPROCESSING PLANT]. Submission No. 15: Final Safety Analysis Report. (Nuclear Fuel Services, Inc., [West Valley, N. Y.]). Revision 2, Aug. 20, 1964. 394p. Dep. CFSTI.

A revision of Section VII (protection of the public) of the West Valley Reprocessing Plant safety analysis report is presented. Possibilities of radioactivity losses from the stack, waste storage tanks, storage lagoon, burial ground, egress of personnel and material, and product shipment were analyzed. Normal operations and the most serious accident credible were analyzed. Revisions of Section VIII (protection of plant personnel) and Section IX (plant operation) are included. Amendments to the safety analysis are summarized as follows: elimination of the Thorex equipment, reduced capacity for stainless steel–cermet fuels, waste storage facilities, and removal of one dissolver. Replies to some questions on safety hazards and criticality problems are given. (M.C.G.)

**28949** (IN-1276) CLARIFICATION OF ELECTROLYTIC DISSOLVER SOLUTION USING A HYDROCYCLONE. Cranney, D. H.; Jacobson, M. E.; Musgrave, B. C. (Idaho Nuclear Corp., Idaho Falls). Apr. 1969. Contract AT(10-1)-1230. 14p. Dep. CFSTI.

Four laboratory-scale hydrocarbons were evaluated for their efficiency in clarification of product solution from electrolytic dissolution of EBR-II fuel. Ninety-five percent removal of stainless steel solids from the overflow stream was demonstrated at 45 psi pressure drop through a hydrocyclone which was 38 mm in diameter and 264 mm long. At these same conditions, 10% removal of EBR-II fissium alloy residues was attained. (auth)

**28950** (IS-T-300) REACTIONS OF THORIUM CARBIDE IN A FUSED SALT–LIQUID METAL SYSTEM. Iverson, Peter Michael (Ames Lab., Iowa). Feb. 1969. Contract W-7405-eng-82. 62p. Dep. CFSTI.

Thesis.

Three methods of recovering spent thorium carbide were investigated. The first involved the reaction between liquid zinc and thorium carbide. The expected reaction product was $ThZn_{9.5}$. Over the temperature span of 500 to 800°C and for equilibration times of up to three days, there was no appreciable amount of $ThZn_{9.5}$ formed. Thorium carbide was also equilibrated with excess $ZnCl_2$ in a LiCl–KCl salt system at 500°C. After 20.5 hrs the reaction was essentially complete. During the first 8 hours the reaction was observed to be kinetically of the zeroeth order. A reaction rate coefficient k of $6.7 \times 10^{-3}$ moles-liter$^{-1}$-hr$^{-1}$, with respect to $ThCl_4$, was measured. Electrolysis of $ThC_2$ in a fused LiCl–KCl electrolyte using a molten zinc cathode was investigated at 500°C. The metal product was a 10 to 16% Th–Zn sponge deposited on a tantalum stirrer above the surface of a 2 to 5% Th–Zn alloy. Current efficiencies varied between 47 and 94% for the cathode and 17 and 38% for the anode. The data indicate that the reaction of thorium carbide with the reactants used in this investigation is kinetically controlled, possibly by a reaction product film such as graphite. (auth)

**28951** (K-Trans-51) METHOD OF ISOTOPIC SEPARATION. I. PHOTOCHEMICAL SEPARATION OF ISOTOPES. Morand, J. P.; Wacongne, M.; Roth, E. Translated by John G. Million (Oak Ridge Gaseous Diffusion Plant, Tenn.), from Energ. Nucl. (Paris), 10: [No. 6], 362-6(Oct. 1968). 15p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 7624. (TSS)

**28952** (ORNL-tr-2116) KARLSRUHE REPROCESSING PLANT. Schueller, [W.] Translated for Oak Ridge National Lab., Tenn., from German Nuclear Forum, ACHEMA XV, Frankfurt am Main, June 26, 1967. 23p. (CONF-670661-1). Dep. CFSTI.

Reprocessing as a part of nuclear power production is discussed. The history and organization of the WAK (Karlsruhe reprocessing) project are considered. The site for the Karlsruhe plant is described along with the solvent extraction process chosen for use. The equipment and operating procedure are discussed. (M.C.G.)

**28953** (ORNL-tr-2146) TECHNICAL PROBLEMS POSED BY THE AQUEOUS METHOD OF FUEL REPROCESSING. Jouan, R. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Ind. At., 12: No. 9/10, 75-8(1968). 7p. Dep. CFSTI.

Various apparatus perfected by the Société Saint-Gobain T. N. for the handling of irradiated fuels are described including: shears for cutting up the pencils of fuel elements for heavy-water reactors, before dissolution of the fissionable matter; a centrifugal extractor, which has distinct advantages as compared to the gravity mixer-settlers; and a system for regulation of the pulsed columns operating with organic continuous phase. (auth)

**28954** EFFECT OF OVERPOTENTIAL ON THE ELECTROLYTIC HYDROGEN–DEUTERIUM SEPARATION FACTOR ON BRIGHT PLATINUM ELECTRODES IN 1.2N HCl–10 PERCENT $D_2O$. Hammerli, M.; Mislan, J. P.; Olmstead, W. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Electrochem. Soc., 116: 779-84(June 1969).

The electrolytic hydrogen–deuterium separation factor, $S_D$, was studied on bright platinum as a function of overpotential in 1.2 N HCl – 10% $D_2O$ at 25°C. $S_D$ increased from $4.1 \pm 0.21$ at −50 mv to $6.5 \pm 0.35$ at −400 mv, and remained virtually constant between −400 mv and −1.2 v applied overpotential. Results agree with published work with $H_2SO_4$ but not HCl as electrolyte. Only because there is a plateau in the $S_D$ vs. overpotential curve are the ohmic potential drop corrections of little significance. The high degree of reproducibility in results achieved, namely ±5%, is believed to be due to (a) effective exclusion of $Cl_2$ (anode gas) from the cathode compartment, (b) relatively short (1 to 60 min) electrolyses, and (c) removal of the large pre-electrolysis cathode from the cell prior to an electrolysis. A leaching–distillation process was also employed as the pretreatment, and is shown to be as effective as pre-electrolysis. Tafel plots obtained before and after electrolysis showed no hysteresis, and are in agreement with recent work on copper cathodes, where cathodic saturation currents are observed. (auth)

**28955** USBM MAY HAVE A NEW WAY TO SHORTCUT $U_3O_8$ ELUEX CIRCUITS. Eng. Mining J., 170: No. 4, 112 (Apr. 1969).

A modified Eluex-type circuit for eluting and recovering $U_3O_8$ from ion-exchange resins is said to cut down on the number of stages, retention time, and resin inventory to 20 to 25% of that in existing circuits. The method is applicable to resin-in-pulp (RIP) and moving bed ion-exchange circuits. A stage of $U_3O_8$ solvent extraction is coupled with each stage of resin elution rather than conducting elution and solvent extraction separately. (F.S.)

**28956** REPROCESSING OF IRRADIATED NUCLEAR FUELS BY USING NONAQUEOUS TECHNIQUES. Boetius, I.; Rabold, H. (VEB Kernkraftwerksbau, Berlin). Kernenergie, 12: 41-7(Feb. 1969). (In German).

Pyrometallurgical, pyrochemical, and volatility reprocessing techniques are described and their efficiency reviewed. (56 references) (M.C.G.)

**28957** ALKALINE EARTH SEPARATIONS ON MICROCRYSTALLINE CELLULOSE COLUMNS. Fritz, James S.; Peters, Mark A. (Ames Lab., Iowa). Talanta, 16: 575-80(May 1969).

Magnesium, calcium, strontium, and barium may be separated quantitatively from each other on a column of microcrystalline cellulose. Barium and radium are also separated from each other. The metal ions are eluted from the column by methanol–hydrochloric acid in varying proportions. The separated metal ions can be titrated with EDTA. Trace amounts of metal ions may be determined by neutron activation. (auth) (UK)

**28958** METHOD FOR DERIVING FORMULAS FOR DETERMINATION OF ISOTOPE SEPARATION COEFFICIENTS IN CERTAIN TYPES OF REACTIONS. Panchenkov, G. M.; Basov, Yu. G. Vestn. Mosk. Univ., Ser. II. Khim., No. 2, 3-6(Mar.-Apr. 1969). (In Russian).

A method for deriving formulas for determination of the isotope separation coefficient for certain types of reactions based on the theory of collisions is suggested. (auth)

**28959** SCANDIUM EXTRACTION IN THE FORM OF A MIXED COMPLEX COMPOUND. Alimarin, I. P.; Sokolova, I. V.; Dol'nikova, S. Ya. Vestn. Mosk. Univ., Ser. II. Khim., No. 2, 87-91(Mar.-Apr. 1969). (In Russian).

The mixed complexing of scandium with N-phenylbenzohydroxamic acid and 5-isotropyl-4-methyl-5′-nitro-2,2′-azodiphenol was studied. The conditions for extraction were found and conclusions made on the extraction mechanism are given. (auth)

**28960** NIOBIUM AND TANTALUM EXTRACTION FROM HYDROCHLORIC ACID SOLUTION USING BENZALDEHYDE AND ACETOPHENONE. Gibalo, I. M.; Al'badri, Dzh. S. Vestn. Mosk. Univ., Ser. II. Khim., No. 2, 98-101(Mar.-Apr. 1969). (In Russian).

The extraction of niobium and tantalum chloride complexes from hydrochloric acid solutions with benzaldehyde and acetophenone was studied. In 8 to 10 M hydrochloric acid solutions niobium formed stable chloride complexes which were extracted quantitatively with the solvents mentioned. Tantalum chloride complexes were unstable and could be extracted from freshly prepared solutions only. The composition of tantalum chloride complexes was determined. The mechanism of reaction was investigated. A method for the separation of niobium from tantalum and titanium was worked out. (auth)

**28961** SOLVENT EXTRACTION OF THE CHELATE COMPOUND OF STRONTIUM WITH AZO–AZOXY PMP. Gorbenko, F. P.; Nadezhda, A. A. (All-Union Scientific-Research Inst. of Chemical Reagents and Chemically Pure Materials for Electron Techniques, Donetsk, USSR). Zh. Anal. Khim., 24: 671-5(May 1969). (In Russian).

Solvent extraction of strontium by means of 4-[[ω-[(6-hydroxy-m-tolyl-onn-azoxy]phenyl]azo]-3-methyl-1-phenylpyrazol-5-ol (azo-azoxy PMP) has been studied. Optimum conditions for the extraction have been found. Strontium is quantitatively extracted with azo-azoxy PMP solutions in a mixture of carbon tetrachloride with 20% (vol) of tributyl phosphate at pH 13 to 14. The composition of the complex extracted is SrAAPMP·2TBP. The strontium content after the extraction is determined complexometrically. Large amounts of Na, K, Ba, Be, Al, Sb, Sn, Cr, Pb, and other elements present in the analyzed solution do not interfere in the extraction; calcium interferes. (auth)

**28962** SEPARATION OF THE BORON ISOTOPES USING THE SYSTEM $BF_3$/PHENETOLE x $BF_3$. Katalnikov, S. G.; Nedzvetskii, V. S.; Voloshchuk, A. M. (Inst. of Chemical Tech., Moscow). Isotopenpraxis, 5: 67-72(Feb. 1969). (In Russian).

A system made up of the $BF_3$/$BF_3$ complex and phenetole, seems to be very promising for the separation of boron isotopes by chemical exchange. Experiments were carried out to determine the dependence of the HETP (height of equivalent theoretical plates) on the flow rate of the $BF_3$-phenetole and the $BF_3$-anisole complexes. The results permitted an evaluation of the diffusion resistances in the liquid and gas phases. In addition, the hydraulic resistance of the packings as a function of the flow rate was determined. The necessity of heating the phenetole-$BF_3$ complex up to the boiling point of phenetole (170°C) for evaporation is demonstrated. The main products of the phenetole decomposition were identified. (auth)

**28963** REVIEW OF URANIUM ORE PROCESSING RESEARCH. White, P. A. F.; Smith, S. E. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Brit. Nucl. Energy Soc., 8: 93-102-(Apr. 1969).

Existing extraction processes are briefly described and a typical cost breakdown for the various stages is given. The current world state of processing research is summarized and improvements in existing techniques which could lead to reduced production costs are discussed. Reference is also made to the treatment of low grade ores. It is concluded that improvements may result from recent innovations in grinding mills. Bacterial leaching and physical ore upgrading are among subjects proposed for further research. (UK)

**28964** INVESTIGATION OF URANYL-ION SORPTION ON THE EDTA FORMS OF ANIONITES. Eristavi, D. I.; Brouchek, F. I.; Berishvili, L. A. (Georgian Polytechnic Inst., Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 53: 325-8(Feb. 1969). (In Russian).

The sorption of uranyl ions from solutions with pH 3 by EDTA (ethylenediaminetetraacetic acid) forms of anionites is confirmed by x-ray technique. On the basis of ir spectroscopic investigation a probable scheme for the formation of the uranyl complexes ($[UO_2(H_2Y)_2]^{2-}$ and $[UO_2Y]^{2-}$) in the EDTA–anionite phase (pH-3) is proposed. In order of efficiency the anionites studied are: AH-2Φr < AB-17 < AB-16. (auth)

**28965** SALTING OUT DURING EXTRACTION OF ACIDS AND SOME RADIOACTIVE ELEMENTS. PART II. SALTING OUT EFFECTS DURING SOLVENT EXTRACTION OF $HNO_3$ AND $HClO_4$ BY TBP. Frolov, Yu. G.; Nasonova, G. I.; Belousova, L. A.; Apter, I. D. At. Energ. (USSR), 26: 423-7(May 1969). (In Russian).

Salting-out effects of different reagents on solvent extraction of $HNO_3$ and $HClO_4$ were studied. These effects in the aqueous phase due to a change in the acid activity coefficients were calculated by Miculin equations. The relationship between the overall salting-out effect and its constituents is proposed. (auth)

**28966** EXTRACTION OF NEPTUNIUM IN FORM OF IONS ASSOCIATED WITH TETRAPHENYLPHOSPHONIUM. Novikov, Yu. P.; Palei, P. N.; Karpushina, S. A. At. Energ. (USSR), 26: 420-3(May 1969). (In Russian).

Neptunium extraction with tetraphenylphosphonium chloride, $(C_6H_5)_4$ PCl(TPP), from solutions of hydrochloric and nitric acids was investigated. Np(IV) in quantities of $10^{-4}$M is almost completely extracted into 0.1M TPP solution in dichlorethane from 6 to 10N HCl and from 1N $HNO_3$. The influence of diluents, and TPP concentration on Np(IV) extraction from hydrochloric and nitric acid solutions was studied. The Np distribution coefficients increased when diluents with higher dielectric constants were used. For the system 0.1M TPP solution in dichlorethane–1N $HNO_3$ the influence of fluorides, phosphates, acetates, and oxalates was studied. For neptunium stripping from the organic phase 0.5N HCl and 1N $H_2SO_4$ were proposed. Under conditions of optimum extraction for Np(IV) (1N $HNO_3$, 0.1M TPP in dichlorethane) the pentavalent neptunium is almost not extracted. The method of neptunium solution purification from plutonium by TPP extraction is given. (auth)

**28967** MUTUAL SEPARATION OF U, Pu, AND FISSION PRODUCTS WITH TRI-ISO-OCTYLAMINE. Akatsu, Johkun (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 6: 285-9(May 1969).

Uranium and Pu were extracted with triisooctylamine in $CCl_4$ from irradiated U dissolved in sulfuric acid, from which Pu was back-extracted with sulfurous acid, and U with 1M $NH_4Ac$–1.5% $H_2O_2$. The decontamination factors were estimated to be $10^2$ for U fraction ($\gamma$ and $\beta$ activities) and $>10^3$ for Pu fraction. (auth)

**28968** REPROCESSING OF IRRADIATED FUELS. Couture, J. (CEA, Marcoule, France). Ann. Mines, 44-55(Jan. 1969). (In French).

Technical and economic aspects of nuclear fuel reprocessing are reviewed, with emphasis on the chemical processes used, technology and plant maintenance features, and problems of waste disposal. Also considered as specific problems encountered as a result of high levels of radioactivity, contamination of the atmosphere and of liquid effluents, the toxicity of plutonium, and the hazards involved in the presence of concentrated fissile materials (criticality). The military requirements for fissile materials have led to rapid resolution of many technical difficulties. The influence of growing demands for commercial power reactors on fuel supply and reprocessing facilities is also considered. Dependency of such commercial development on reprocessing is emphasized. This new chemical industry has incorporated safety features that allow it to be situated relatively near populated areas. (BBB)

**28969** ENRICHMENT OF STABLE ISOTOPES. I. SEPARATION FACTOR OF LITHIUM ISOTOPES IN ION EXCHANGE CHROMATOGRAPHY. Hagiwara, Zenzi; Takakura, Yoshihisa (Tohoku Univ., Sendai). J. Nucl. Sci. Technol. (Tokyo), 6: 279-84(May 1969).

The separation factor ($\alpha$) of Li isotopes was determined by subjecting LiOH, Li acetate, Li citrate, and Li HEDTA of various

concentrations to ion exchange reactions with sulfonated polystyrene–divinylbenzene copolymers of various degrees of crosslinking. With the view to accurate determination of $\alpha$ by enlarging the scale of experiment, frontal analysis in the column operation was performed with exchange columns containing Dowex 50 W, X-12 and 16, or else Diaion SK, X-16 (X meaning crosslinkage of the exchanger). Experimental results revealed the $\alpha$ values to be always higher with Li acetate than with Li hydroxide as eluant. Also Li citrate eluants gave values somewhat lower than with Li acetate system. Exchange systems with Dowex 50 W, X-12 and 16, with various concentrations of Li acetate, yielded single stage isotopic separation factors ranging from 1.0025 to 1.0036. The corresponding value was 1.0027 for the system involving Dowex 50 W, X-16, 20 to 50 mesh and 0.109M solution of dilithium salt of N'-2-(hydroxyethyl)ethylenediamine-NNN'-triacetic acid (HEDTA) (auth)

**28970** RAPID GRAM-SCALE SEPARATION OF CURIUM FROM AMERICIUM AND LANTHANIDES BY CATION EXCHANGE CHROMATOGRAPHY. Hale, W. H.; Lowe, J. T. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Inorg. Nucl. Chem. Lett., 5: 363-8(May 1969).

Very fine Dowex 50 W-X 8 resin in the $Zn^{2+}$ form was employed in pressurized stainless steel columns, the high flows attainable reducing radiation damage to the resin. The Cm and Am were separated from fission product lanthanides in nitrate solution by elution with DTPA (diethylenetriamine pentaacetic acid) at flow rates up to 20 ml/cm$^2$/min. A good separation of Cm and Am was achieved with DTPA. Details are given of the apparatus and procedure, including separation factors obtained. (UK)

**28971** APPLICATION OF PLAN B FOR STUDY OF THE EXTRACTION PROCESS FOR SEPARATION OF ZIRCONIUM AND HAFNIUM. Golikova, T. I.; Granovskii, Yu. V.; Igonina, I. V.; Komissarova, L. N.; Maksimova, E. P.; Nikolaeva, L. S.; Smirnova, N. S. Zavod. Lab., 35: 321-3(1969). (In Russian).

Optimum conditions were determined for separation of Zr from Hf in the extraction from hydrochloric acid solutions by heptyl alcohol. The construction and statistical characteristics of the plan $B_4$ are described. A mathematical model was obtained in the form of an equation of regression of the second order, connecting the coefficient of separation and extraction with the concentration of the metal, acids, and extracting agent and with the ratio of phases. A factor of separation equal to 6 was obtained on extraction of 53%. (tr-auth)

**28972** EXTRACTION OF RuNO NITRATO COMPLEXES BY TERTIARY AMINES. Hallaba, E.; Azzam, R.; Ragab, A. (Atomic Energy Establishment, Cairo). Microchem. J., 14: 126-37(Mar. 1969).

The extraction behavior of the fission product RuNO nitrato complex in tridodecylamine (TLA)–$HNO_3$ system was studied. The role of acid, neutral salts, TLA concentration, and the type of diluents were investigated. Nitric acid and uranyl nitrate were found to have satisfactory salting-out effects in the system, and diluents were found to have no significant effects on the extraction pattern of the element. Results from a study of the extraction from different acid media, showed that an increase of $HNO_3$ concentration decreased the extraction of Ru sharply, an increase of HCl had almost no effect on the distribution of the Ru, and an increase of $H_2SO_4$ had an intermediate influence. (D.H.M.)

**28973** EXTRACTION OF RARE EARTH ELEMENTS BY BIS(2-ETHYLHEXYL) ESTER OF ORTHOPHOSPHORIC ACID FROM NITRATE SOLUTIONS. Mikhailichenko, A. I.; Pimenova, R. M. Radiokhimiya, 11: 8-13(1969). (In Russian).

The rules of extraction of rare earth elements using the bis(2-ethylhexyl) ester of orthophosphoric acid from nitrate solutions were studied. The coefficients of distribution and the constants of extraction were determined. The compositions of compounds extracted by the organic phase were established. In the region of low and moderate concentrations of nitric acid, rare earths are extracted in the form of $M(HA_2)_3$ complexes, and in the region of higher concentrations in the form of solvates, $Ln(NO_3)_3 \cdot 3HA$. In relation to the acidity of the aqueous phase, the bis(2-ethylhexyl) ester of phosphoric acid can extract according to the mechanism typical for acid extracting agents and according to the mechanism characteristic for neutral organic phosphorus compounds. (tr-auth)

**28974** ADSORPTION OF MICROAMOUNTS OF NIOBIUM FROM AQUEOUS SOLUTIONS ON ASHLESS ACTIVATED PLATINIZED COAL. Nikol'skii, B. P.; Andreev, V. I.; Mosevich, A. N.; Lyubtsev, R. I.; Polyakov, M. S. Radiokhimiya, 11: 54-61(1969). (In Russian).

Tracer studies of niobium sorption by ashless activated platinized coal by an electrostatic mechanism are described. Nitrate, perchlorate, and sulfate ions did not have any influence on the character of the sorption of the oxalate complex by coal. The presence in oxalate solutions of acetate ions at pH = 6.0 led to the partial or complete irreversibility of the sorption of niobium by coal, which, apparently, is connected with the formation of colloidal forms of niobium hydroxide. The sorption mechanism is determined by the composition of the solution and does not depend on its method of preparation. (tr-auth)

**28975** APPLICATION OF ALKYLAMMONIUM SALTS FOR DISSOLUTION OF INORGANIC COMPOUNDS. IV. SOLUBILITY OF THE MIXED FLUORIDES OF U(IV) AND CE(III) IN SOLUTIONS OF TRIDECYLAMMONIUM FLUORIDE. Lipovskii, A. A.; Nikitina, S. A. Radiokhimiya, 11: 51-4(1969). (In Russian).

The dissolution of the mixed fluorides of U(IV) and Ce(III) in solutions of tridecylammonium fluoride in benzene was studied. The coefficients of separation and solubility were determined by the ratio of uranium and cerium in the fluoride precipitates. It was concluded that this relation is a result of the formation of anomalous mixed crystals with crystalline lattices of various types. (tr-auth)

**28976** CARBURIZATION OF MICROAMOUNTS OF THE RADIOACTIVE ISOTOPES OF LIGHT RARE EARTH ELEMENTS AND YTTERBIUM BY AN AMALGAM OF SODIUM IN THE PRESENCE OF MACROAMOUNTS OF TERBIUM, ERBIUM, AND LUTETIUM. Novgorodov, A. F.; Novikova, M. M.; Khalkin, V. A. Radiokhimiya, 11: 85-8(1969). (In Russian).

With vigorous stirring of an amalgam and the solution, macroamounts of light rare earth elements from La to Gd and Yb can be estracted from acetate buffer solutions. With a single carburization 40% of the Gd and more than 50% of the other carburized elements are extracted. Carburization by a sodium amalgam is convenient for the rapid separation of rare earth products from target materials after irradiation of terbium by protons at 660 MeV. (tr-auth)

**28977** RADIOACTIVE ISOTOPES OF TELLURIUM AS INDICATORS OF THE COMPLETENESS OF THE SEPARATION OF POLONIUM. Teplykh, L. A. Radiokhimiya, 11: 122-3 (1969). (In Russian).

The efficiency of the electrochemical separation of tellurium is identical to the efficiency of the separation of polonium. Therefore, a method was proposed to check the electrochemical separation of $^{210}$Po using the radioactive isotopes of tellurium, especially $^{127m}$Te–$^{127}$Te. (tr-auth)

**28978** CONCERNING THE EXTRACTION OF HEXAVALENT URANIUM BY BIS(2-ETHYLHEXYL) ESTER OF PHOSPHORIC ACID FROM PERCHLORATE SOLUTIONS WITH HIGH CONCENTRATIONS OF PERCHLORIC ACID. Nemodruk, A. A. Radiokhimiya, 11: 3-7(1969). (In Russian).

The extraction of hexavalent uranium by solutions of the bis(2-ethylhexyl) ester of phosphoric acid in $CCl_4$ from perchlorate solutions was studied in relation to the concentration of $HClO_4$. With an increase in the concentration of $HClO_4$, the coefficient of distribution of U(VI) decreased sharply, reaching a minimum at a concentration of 4M. With further increases in the concentration of $HClO_4$, the distribution again increases. Such a relation of the coefficients of distribution of U(VI) is explained by the fact that from solutions with concentrations of $HClO_4$ below 4M, U(VI) is extracted according to an ion-exchange mechanism with participation of the $UO_2^{2+}$ ion in the formation of the extracted complex. The extracted complex also requires participation of the $UO^{4+}$ ion. (tr-auth)

**28979** LARGE-SCALE EXPLOITATION OF FISSION-PRODUCT RHODIUM AND PALLADIUM. Rohrmann, C. A. (Battelle Memorial Inst., Richland, Wash.). Isotop. Radiat. Technol., 6: 352-8(Summer 1969). (BNWL-SA-2040).

The rare and valuable noble metals rhodium and palladium are among those elements produced in highest yield in the fission process, particularly in the fission of plutonium. The anticipated growth of the atomic power industry is at such a rate that within 10 years the discharge of wastes from the chemical processing of spent fuels from U. S. power reactors will contain more rhodium than is now supplied annually to American industry from conventional mineral sources. A similar situation should exist for palladium before the turn of the century. In addition, the few residual radioactive isotopes of rhodium and palladium known to be present in spent fuel are of such low concentrations, low activities, or low energies that expectations are promising for application of these isotopes in the important major large-scale uses. The large-scale exploitation of these elements from this

new (and until recently nonexistent) source affords a possible ever-growing supply of these precious metals to serve mankind's essential needs, e.g., as catalysts in fertilizer production and as materials for communications equipment. (auth)

**28980** THE BEHAVIOR OF $^{55}Fe$ IN PURIFICATION OF WASTE WATER BY COAGULATION. Pavlov-Verevkin, B. S. Radiokhimiya, 11: 124-6(1969). (In Russian).

Deactivation of waste solutions from radioactive $^{55}Fe$ with sufficient efficiency was achieved by a single coagulation in a neutral or weakly alkaline environment. In some cases, when the constant of light-hydrolyzing salts in the solution is insufficient for the formation of macroscopic precipitates, it is necessary to add coagulators, mainly the salts of trivalent iron. Deactivation occurs basically by the formation of insoluble hydrates of iron oxide and their subsequent coagulation. The residual radioactivity of purified water corresponds to the solubility of iron hydroxide. (tr-auth)

**28981** RADIOACTIVE WASTE HANDLING AT SOVIET ATOMIC POWER STATIONS. Kolychev, B. S.; Matveev, A. N.; Khonikevich, A. A. At. Energ. (USSR), 26: 411-19(May 1969). (In Russian).

The problems of radioactive waste handling at atomic power stations in the USSR are discussed. Handling procedures include radioactive waste treatment, decontamination, long-term storage, transportation and disposal. These problems were studied on the data obtained from the operation of the Novo-Voronezh and Beloyarsk Atomic Power stations and on the results of the research work at the Melekess Atomic Reactor Research Institute. Some data on the research and development in this field are presented. (auth)

**28982** PROCESS FOR PREPARING STERILE RADIOACTIVE MATERIAL OF THE PARENT-DAUGHTER TYPE. Bruno, Gerald A.; Haney, Thomas A.; Numerof, Paul; Reinhardt, Karl (to E. R. Squibb and Sons, Inc.). U. S. Patent 3,440,423. Apr. 22, 1969. Filed Apr. 10, 1967.

An essentially closed system for preparation of sterile radioactive materials includes a column of radioactive material closed at both ends with pierceable closures, preferably made from resilient material; a hypodermic syringe containing a sterile eluting solution; a hypodermic needle that is used to pass through the aperture in the closure and pierce the top of the column so that the solution can be introduced into the top of the column. Attached to this assembly is a tube containing hypodermic needles at both ends, one needle for insertion into the bottom of the column and the other needle for insertion through the closure of an empty sealed vial, which is also pierced by another hypodermic needle open to the atmosphere through a sterile plug of cotton, to provide a sterile system for recovering the elute coming from the sealed column of radioactive material. The apparatus is useful for eluting radioactive Tc from $^{99}Mo$. (Offic. Gaz.)

**28983** CATION EXCHANGE SEPARATION OF ZIRCONIUM AND HAFNIUM. Otsuka, Takeshi; Miyazaki, Hideo (Nippon Mining Co., Tokyo). Nippon Kogyo Kaishi, 85: 269-74(Apr. 1969). (In Japanese).

Zirconium and hafnium can be separated by ion exchange by loading both on a cation exchange column and separating the two on a second connected column. Fractional elution with 1.2N $H_2SO_4$ gave better separation than bulk elution with 1.0N $H_2SO_4$, but best separation was obtained by elution with acetone–$H_2SO_4$ or methylethyl ketone–$H_2SO_4$ mixtures. An elution flow rate of 0.3 to 5 ml/min/cm$^2$ results in good separation of the ions; however, a small amount of Hf is always eluted before the main peak of Zr appears, so it is difficult to obtain Hf-free Zr. (NSA of Japan)

**28984** ION EXCHANGE PROCESS FOR RECOVERING AMERICIUM AND CURIUM. Wheelwright, Earl J. (to United States Atomic Energy Commission). U. S. Patent 3,445,201. May 20, 1969.

A process is described for separating Am and Cm values from lanthanide and actinide values and from each other by elution through a cation exchange resin bed with diethylenetriaminepentaacetic acid to separate the Am and Cm from the other values present. The Am and Cm values are then separated from each other by elution with nitrilotriacetic acid. (AEC)

**28985** ION-EXCHANGE SEPARATION OF VANADIUM, ZIRCONIUM, TITANIUM, MOLYBDENUM, TUNGSTEN, AND NIOBIUM. Ferraro, T. A. (Army Materials and Mechanics Research Center, Watertown, Mass.). Talanta, 16: 669-79(June 1969).

Schemes for the separation of two or more of the elements vanadium, zirconium and/or titanium, molybdenum and tungsten from each other and from relatively large amounts of niobium were developed, a strongly basic anion-exchange resin being used. Interference from niobium is avoided by using hydrofluoric acid to elute vanadium, zirconium, titanium and molybdenum. The application of coupled columns to improve the efficiency of separation of multicomponent mixtures is demonstrated. The use of an "interval" equation defining the volume interval between successively eluted solutes is proposed for calculating the column length required for a particular separation. This equation is especially useful for determining the extent to which a column must be lengthened when overlapping occurs because of high column loading. (auth) (UK)

**28986** SEPARATION AND RADIOCHEMICAL DETERMINATION OF URANIUM AND THE TRANSURANIUM ELEMENTS USING BARIUM SULFATE. Sill, C. W. (Atomic Energy Commission, Idaho Falls, Idaho). Health Phys., 17: 89-107(July 1969).

Precipitation of large ter- and quadrivalent ions by barium sulfate was extended to the separation of uranium and the transuranium elements both from other elements and from each other. From 25 ml of solution containing sulfuric acid, potassium sulfate, and hydrogen peroxide, carrier-free quantities of barium, the light lanthanides, lead, bismuth and all the elements from radium through at least californium, except uranium, are precipitated to better than 99% by only 5 mg of barium ion. Polonium is also carried less completely. Uranium can be included by reducing it to the quadrivalent state with titanium trichloride either before or after precipitation of barium sulfate. Like uranium, the transuranium elements through americium can be prevented from precipitating by oxidizing them to the hexavalent state, in which the oxygenated cation is too large to fit into the barium sulfate lattice. Also, because of their markedly different oxidation potentials, uranium and the first four transuranium elements can be separated efficiently from each other by proper choice of oxidant. The barium sulfate precipitate can be alpha counted directly or the radionuclides can be electrodeposited for alpha spectrometry. This procedure permits not only traditionally difficult separations such as americium from curium, or the determination of extremely minute quantities of one transuranium element in the presence of large quantities of another, to be made simply and quickly, but mixtures of uranium and the first four transuranium elements can be separated sequentially from each other and identified on the same sample in a single procedure. Furthermore, since virtually every alpha-emitting nuclide known can be precipitated with barium sulfate under the same conditions, chemical separation can be employed to eliminate absorbing materials and permit a true gross alpha determination in large samples. (auth) (UK)

**28987** OXYGEN ISOTOPE SEPARATION IN ZIRCONIA ELECTROLYTE CELLS. Spacil, H. S.; Tedmon, C. S. (General Electric Co., Schenectady, N. Y.). Nature (London), 222: 662-3 (May 17, 1969).

Solid oxide electrolytes with predominantly oxide ion ($O^{2-}$) conductivity should show isotope effects resulting from the different mobilities of $^{16}O$, $^{17}O$, and $^{18}O$ through the anion sub-lattice, and the oxygen-containing gas stream leaving the cathode of an oxide electrolyte cell should be enriched in the heavier isotopes because of the lower mobility of $^{17}O$ and $^{18}O$. Experimental work is described, using yttria-stabilized zirconia, with a view to examining the magnitude of this effect. Dense Ni was used to shield the hot electrolyte outside the active cell area in order to prevent surface exchange of oxygen isotopes in the cathode gas with the electrolyte. The porous Ni anode was depolarized with wet $H_2$, and about 90% of the $H_2O$ vapour entering the cathode as $H_2O/H_2$ mixture was dissociated and monitored by a downstream auxiliary electrode. The cell temperature was about 1,000°C, and the average current density was 1.7 A/cm$^2$, resulting in a cell voltage of 1.1 V. The cell described may be operated as a single stage or multistage cascade. The product was analyzed by a mass spectrometer, and isotope ratios are tabulated. An isotope effect was found to exist, but only semi-quantitative evaluation of the data was possible. The concentration per stage was found to be 2.5 to 3%, as against a predicted value of about 6. (UK)

**28988** SEPARATION OF URANIUM AND THORIUM FROM PLUTONIUM. Silver, Gary L. (to United States Atomic Energy Commission). U. S. Patent 3,443,912. Apr. 26, 1969.

A precipitation process for purification of Pu comprises dissolving the Pu and its decay products in $HNO_3$ or HCl solution, adding a reducing agent to convert and maintain plutonium ions in the plus three ionic state, evaporating the solution to gradually and progressively precipitate U and Th as phosphites and hypophosphites and separating the latter precipitate from the solution. (AEC)

**28989** SEPARATION OF ZIRCONIUM AND HAFNIUM BY LIQUID–LIQUID EXTRACTION USING ALIPHATIC KETONES. Otsuka, Takeshi; Miyazaki, Hideo (Nippon Mining Co., Saitama, Japan). Denki Kagaku, 37: 263-9(Apr. 1969). (In Japanese).

The extraction mechanism of Zr and Hf in aliphatic ketone–thiocyanic acid systems depends on the formation of an extractable species by displacing the coordinated water around the metal by thiocyanate anion and aliphatic ketone. The relation between the dielectric constant of aliphatic ketones and their structure, and the distribution coefficient of Zr and Hf an their separation factors were studied. If the-R′ (alkyl group) in aliphatic ketone of $CH_3-CO-R'$ form is a straight chain, formulas $\log K_D \propto \epsilon$ and $\log \beta \propto \epsilon$ were derived. $K_D$ is the distribution coefficient of Zr or Hf, $\beta$ is the separation factor, and $\epsilon$ is the dielectric constant of the ketone. Structurally, if the -R′ group is a longer chain or of branched form, both distribution coefficients decrease, but that of Zr particularly, as a result their separation factor increases remarkably. Thus the more effective separation of two metals can be accomplished by extraction, using a mixture of suitable amounts of ketones having a higher dielectric constant than a pure ketone. Even though thiocyanic acid is unstable in this system, if an aliphatic ketone of high dielectric constant is used, its decomposition can be avoided. (NSA of Japan)

**28990** PRECIPITATION AND COPRECIPITATION IN THE PRESENCE OF CHELATING AGENTS. V. THE CONTAMINATION OF BARIUM CHROMATE BY URANIUM FISSION PRODUCTS IN EDTA. Benes, J.; Vobecky, M.; Barta, K. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 34: 1523-32(May 1969).

The presence of ethylenediaminetetraacetic acid (EDTA) substantially decreases the contamination of barium chromate by the fission products of uranium; the yield of coprecipitation is dependent on the pH value. Contamination by strontium and cerium has been investigated as a function of the precipitation conditions, namely the concentration of EDTA, excess of precipitant, pH value of the solution, temperature, and amount and time of aging of the solution. The correlations found were interpreted from the point of view of the stability of the complex compounds of EDTA with the corresponding metal cations and of the equilibrium of chromate and bichromate ions in the solution. The experimentally found dependence of coprecipitation yield of strontium on the amount of precipitate satisfied the Chlopin's relationship. (auth)

**28991** SEPARATION OF RADIOCERIUM FROM THE SOLUTION OF FISSION PRODUCTS OF URANIUM BY EXTRACTION BY DI-(n-OCTYL)PHOSPHORIC ACID. Krtil, J.; Bezdek, M. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 34: 1406-12(May 1969).

Separation of radiocerium by a selective extraction has been studied using the solution of di-(n-octyl) phosphate acid in hexane. The dependence of the extraction yield of cerium on the concentration of nitric acid, oxidizing agent (bromate), carrier, and extracting agent, respectively, has been determined and thus the optimum conditions for the cerium extraction were found. The co-extraction of certain fission products and the co-extraction of uranium as well as the effect of the presence of certain elements from the cladding materials of fuel elements on the cerium extraction yield were studied under the same conditions. The reproducibility of results and the practical applicability have been confirmed by isolation of radiocerium from the solution of irradiated uranium(IV) oxide. (auth)

**28992** ISOTOPE-EXCHANGE REACTION STUDIES IN A ONCE-THROUGH FLUID COLUMN. Hodor, I.; Marginean, P.; Mercea, I.; Mercea, V.; Mueller, A.; Olariu, A.; Peculea, M.; Smeu, L. (Institut fuer Atomphysik, Cluj). Isotopenpraxis, 5: 112-15(Mar. 1969). (In German).

The isotope separation process by isotope exchange reaction between hydrogen and water using steam with once-through circulation of the fluids was studied with special attention to its limitations by the catalyzed exchange reaction or diffusion processes. (auth)

**28993** ANALYTICAL SEPARATIONS OF METALS BY COLUMN CHROMATOGRAPHY ON MICROCRYSTALLINE CELLULOSE. Peters, Mark Anthony. Contract W-7405-eng-82. Ames, Iowa, Iowa State Univ., 1968. 70p. (IS-T-235). Thesis.

A new form of cellulose, microcrystalline cellulose, was investigated as a support for column chromatography. Mixtures of methanol and hydrochloric acid were used as eluents for the quantitative separations of Mg(II), Ca(II), Sr(II), and Ba(II) from each other at the milligram level and also with $^{85}Sr$(II) and $^{133}Ba$(II) at the parts per million level. The Sr(II) and Ba(II) in the above separation scheme were also determined at the milligram level by neutron activation. Sr(II) and Ba(II) were quantitatively separated at the tracer and milligram concentration levels on cylindrical and conical shaped columns. The conical column, which produced superior separations, was used to separate a trace of Ba(II) ($10^{-7}$ g.) from 10.0 mg. of Sr(II). The Ba(II) was then determined by neutron activation. Quantitative separations of Ba(II) from $^{226}Ra$(II); Ba(II) from Er(III); and Mg(II), Eu(III), Sr(II), and Ba(II) from each other were also achieved. The alkali metals, Li(I), Na(I), and K(I), were quantitatively separated on microcrystalline cellulose columns with a methanol–hydrochloric acid–water eluent. The alkali metals, Cs(I), Rb(I), K(I), and Na(I), at the milligram level were quantitatively separated from each other with a phenolic eluent. Traces of Al(III) were quantitatively separated from rare earths. Ethanol–hydrochloric acid eluents separated mole ratios of rare earth to Al(III) from the 10 to 1,000. The transition metals, Fe(III), Cu(II), Co(II), Cr(III), and Ni(II), were separated from each other with acetone–hydrochloric acid eluents. The stationary and mobile phases in cellulose columns for various eluents were also studied. The volume, weight, and concentration of species were determined for each phase. A formula was derived which related $R_f$ values of paper chromatography to retention volumes ($\bar{v}$). This formula, $\bar{v} = V_m/R_f$, in which $V_m$ = volume of mobile phase in a cellulose column, was then used either to predict the feasibility of a separation or to choose the proper eluent for a particular separation from published $R_f$ data. (Disser. Abstr.)

**28994** SOME LAWS OF ISOTOPE SEPARATION BY CHEMICAL EXCHANGE (WITH SPECIAL RESPECT TO THE EXTRACTIVE SEPARATION OF THE LITHIUM ISOTOPES). Rozen, A. M.; Mikhailichenko, A. I. (Moscow Chemical-Tech. Inst.). Isotopenpraxis, 5: 105-12(Mar. 1969). (In Russian).

A theoretical analysis of isotope partition functions in molecules containing two atoms shows the partition functions to depend on the physicochemical properties of the molecules. The obtained theoretical conclusions were qualitatively verified by experimental studies of the lithium isotope separation in various extraction systems. The results also offer an explanation for the relatively small separation parameters ($\alpha$-1) found in the separation of lithium isotopes by the extraction method. (auth)

# EARTH SCIENCES

## Geology and Hydrology

*Refer also to abstracts 28744, 28749, 29008, and 29237.*

**28995** (IFA-MR-31) CONTRIBUTION TO THE STUDY OF MOVEMENT OF SAND IN THE GULF OF EFORIA BY THE METHOD OF RADIOACTIVE TRACERS. Gaspar, E.; Oncescu, M.; Serbanescu, O. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1968. 18p. (In French). Dep.

Tracer studies using $^{192}Ir$ on the movement of sand in the Gulf of Eforia showed that sediments in the Eforia zone are oriented towards the east. This direction is the result of hydrometeorologic features that generally exist over the southern coast of the Romanian shore. The equipment and method used permit measurements to be made over a long period of time. They can be applied with good results for all studies executed on the mouth of the Danube, for the repair of the navigability of the Sulina Canal, or in the zone south of the coast, for the new harbor construction and hydrotechnique management, which is of economic interest. (P.C.H.)

**28996** (ORNL-4341) RADIOISOTOPIC SAND TRACER STUDY (RIST). Status Report for May 1966-April 1968. Acree, E. H.; Case, F. N.; Cutshall, N. H.; Brashear, H. R. (Oak Ridge National Lab., Tenn.). May 1969. Contract W-7405-eng-26. 52p. Dep. CFSTI.

The Radioisotopic Sand Tracer Study (RIST) was initiated in May 1966 as a multiagency cooperative effort to develop technology and survey equipment for sediment transport studies with the objective of determining direction and amount of sand movement. To prove the system effective a test was planned to determine how sand moves around a headland where a change in beach direction occurs on either side of the headland. The first two years of the work done at ORNL consisted primarily in developing equipment and techniques for studying sand transport in the littoral zone. Field operations to evaluate the equipment and to develop more effective procedures were conducted at Cape Kennedy, Florida, at Surf, California, and at Point Conception, California. In these tests sand tagged with $^{133}Xe$ was released on the ocean floor in the study area at a depth of 30 ft. The dispersion and transport of the labeled sand were observed with cesium iodide detectors contained in a specially designed detector transport vehicle (ORNL Underwater Survey System). The detector assembly was towed through the ocean by an amphibious vessel. Charts of the isoactivity contours were prepared from some of the data to estimate direction and velocity of sand transport. (auth)

**28997** (TID-24933) EXPERIMENTAL TEST OF MATHEMATICAL MODEL PREDICTING TRITIUM MOVEMENT THROUGH A TROPICAL RAIN FOREST. Jordan, Carl F. (Puerto Rico Nuclear Center, Rio Piedras); Koranda, John F.; Martin, John R. (California Univ., Livermore. Lawrence Radiation Lab.); Kline, Jerry R. (Argonne National Lab., Ill.). [nd]. Contract AT(40-1)-1833. 3p. (CONF-690508-2). Dep. CFSTI.

From Conference on Radiation and Isotope Technology in Latin American Development, San Juan, Puerto Rico.

An experimental test of a mathematical model for predicting tritium movement through a tropical ecosystem is described. The ecosystems consisted of litter, soil, water vapor, leaves of saplings, and roots of canopy trees. The model is based on measurements of water content of ecosystem compartments and flow of water between compartments. The model predicted a sharp rise in tritium in the free water of the litter, soil, wood, and leaves, specific activity of tritium in all compartments to reach a maximum in a week and the maximum to be followed by a rate of decrease with a residence half life of ~6 days. The prediction of the maximum within a week proved to be accurate. The rate of increase was faster than predicted. Residence half time in the leaves was ~6 days but residence half time in the soil and litter occurred as predicted when the soil was close to saturation, a condition of the rainy season. The rate of tritium loss was not steady. (F.S.)

**28998** (USGS-474-9) LITHOLOGIC LOGS OF THE UCe-2, UCe-3, AND UCe-16 DRILL HOLES, STONE CABIN AND MONITOR VALLEYS, NYE COUNTY, NEVADA. Central Nevada-27. Hoover, D. L.; Hedlund, D. C.; Snyder, R. P. (Geological Survey, Denver, Colo.). Mar. 17, 1969. Contract AT(29-2)-474. 15p. Dep. CFSTI.

UCe-2 in Stone Cabin Valley and UCe-3 in Monitor Valley were drilled to depths of 1,659 and 2,000 feet, respectively, for geothermal measurements. The holes were spudded in welded tuff. UCe-2 penetrated only welded tuff. UCe-3 penetrated intercalated welded tuffs and bedded tuffs and bottomed in andesitic lava flows, breccias, and sediments derived from the andesitic rocks. UCe-16 in Monitor Valley was drilled as an exploratory hole to a depth of 4,353 feet. The hole was spudded in alluvium. Beneath the alluvium intercalated welded tuffs and bedded tuffs were penetrated before the hole was bottomed in rhyolite. (auth)

**28999** CONDITIONS OF FORMATION OF A SORPTION BARRIER TO THE MIGRATION OF URANIUM IN AN OXIDIZING ENVIRONMENT. Dement'ev, V. S.; Syromyatnikov, N. G. (Inst. of Geological Sciences, Alma-Ata, USSR). Geochem. Int. (Engl. Transl.), 5: 394-400(1968).

Translated from Geokhimiya, No. 4, 459-65(1968).

Maximum sorption and minimum solubility of uranium occur in natural waters with pH of $6.0 \pm 0.5$. Anionic forms of uranium predominate in waters with pH $\simeq 5.5$, cationic forms in waters with pH $\simeq 6.5$. Solubility of uranium is shown also to be a function of $CO_2$ content. In oxidizing environments, the combined conditions of maximum sorption and minimum solubility may impede or prevent the migration of uranium. (auth)

**29000** A RADIOLOGIC STUDY OF THE GRANITES OF THE ORTAU MASSIF, CENTRAL KAZAKHSTAN. Syromyatnikov, N. G.; Ivanova, E. I. (Inst. of Geologic Sciences, Alma-Ata, USSR). Geochem. Int. (Engl. Transl.), 5: 299-305(1968).

Translated from Geokhimiya, No. 3, 315-22(1968).

The entire Ortau massif has a substantial deficiency of $^{234}U$ relative to $^{238}U$ and also of both of these relative to $^{230}Th$ and $^{226}Ra$. The ratio of $^{230}Th$ to $^{226}Ra$ and of $^{238}Th$ to $^{230}Th$ agrees with equilibrium ratios to within 10%. These data suggest a maximum weathering time for the massif of $5 \times 10^5$ years. (auth)

**29001** ISOTOPIC COMPOSITION OF URANIUM AND ACTINIUM CONTENT IN MINERALS AND NATURAL WATERS. Kadyrov, N. B.; Isabaev, E. A.; Asylbaev, U. Kh.; Abil'daev, A. Kh.; Cherdyntsev, V. V. (Kazakh State Univ., Alma-Ata, USSR. Geological Inst., Moscow). Geochem. Int. (Engl. Transl.), 5: 418-19(1968).

Translated from Geohimiya, No. 4, 492-4(1968).

The $^{234}U/^{238}U$, $^{235}U/^{238}U$, and $^{227}Ac/^{226}Ra$ ratios in low uranium content sulfide and oxide minerals and in ground waters are reported. The $^{235}U/^{238}U$ ratio in all samples varies by less than 1% sulfides may be deficient in $^{234}U$ by as much as 20%, while oxides are correspondingly enriched. Ground water from granite is also enriched in $^{234}U$ by as much as 350%. Some minerals samples are enriched in $^{227}Ac$, but this does not correlate with $^{234}U$ enrichment. (auth)

**29002** TEST OF CONSTANCY OF SELF-DIFFUSION COEFFICIENTS. Phillips, Ronald E. (Univ. of Kentucky, Lexington). Soil Sci. Soc. Amer., Proc., 33: 322-5(Mar.-Apr. 1969).

A method is outlined which allows one to determine the constancy of diffusion coefficients measured by the use of Fick's second law, subject to two sets of initial and boundary conditions if the spatial distribution of the diffusing ion is known. The constancy of published self-diffusion coefficients was analyzed for illustrative purposes; they were found to remain essentially constant throughout the diffusion period. The method can be used to calculate constant diffusion coefficients from experimental spatial-distributions of the diffusing ions. Diffusion coefficients calculated in this manner were compared with the values calculated by other methods; the values are the same, within experimental error, as predicted by theory. (auth)

**29003** IZOTOPY RADONA I KOROTKO-ZHIVUSHCHIE PRODUKTY IKH RASPADA V PRIRODE. (Radon Isotopes and Short-Lived Products of Their Natural Decay). Serdyukova, A. S.; Kapitanov, Yu. T. Moscow, Atomizdat, 1969. 312p.

The formation of radon isotopes and their short-lived decay products, their chemical and physical properties, and distribution and isotopic ratios in nature are discussed. Methods for the measurement of the concentration of radon isotopes and their decay products and the determination of their emanating and diffusion coefficients under laboratory and natural conditions are described. These studies showed the possibility of the application of radon isotopes and their decay products to the location of deposits of radioactive elements, geological mapping, studies of atmospheric phenomena, and in medicine. The biological action of these isotopes was examined by dosimetric measurements of their content in the air from industrial operations. Engineering and technical measures necessary for the reduction of these isotopes to permis-

sible levels are discussed. The information is applicable to a wide range of specialists operating in the field of natural radioactivity. (tr-auth)

**29004** A NEGATIVE ANOMALY OF THE $^{234}U/^{238}U$ RATIO. Yaron, F.; Schulman, N. (Hebrew Univ., Jerusalem). Israel J. Earth-Sci., 16: 229-30 (Dec. 1967).

During the isotopic analysis of a chalk sample an anomaly in the $^{234}U/^{238}U$ ratio was noted. This ratio which is usually unity was found sometimes to exceed this value. The $^{234}U$ excess in waters and in minerals derived from these waters can be explained by relatively greater leaching of $^{234}U$ isotope from the rock, due to lesser stability in the lattice caused by nuclear transmutation accompanied by recoil and by chemical bond changes. Assuming that $^{234}U$ is preferentially leached, rocks deficient in this isotope might be found. In the chalk a $^{234}U/^{238}U$ ratio of $0.038 \pm 0.022$ was found, significantly less than the equilibrium value and much less than the higher ratio usually found in carbonates. A similar negative anomaly in the $^{234}U/^{238}U$ ratio has been mentioned before but little attention has been given either to the phenomenon itself or to the possible inaccuracy which the leaching of $^{234}U$ may introduce into the $^{230}Th/^{234}U$ radiodating method. Application of radiodating may still be possible with a qualification on the uncertainty concerning the time and rate of leaching. Since there is little doubt $^{234}U$ has been leached from the chalk it may be possible to calculate its age from the $^{230}Th/^{238}U$ ratio assuming that no extensive leaching of $^{238}U$ has occurred and that $^{234}U$ leaching occurred quite recently. Validity of this assumption may be questionable and must wait for corroboration by some correlation of geological and geochemical information. (BBB)

# Meteorology

*Refer also to abstracts 29068, 29118, and 29476.*

**29005** (AD-683778) FALLOUT COMPUTATIONAL TECHNIQUES. Final Report. Petty, J. S.; Curtis, G. B.; Wendland, D. E. (American Research Corp., Fullerton, Calif.). Jan. 31, 1968. Contract N00228-67-C-2005. 80p. (ARC-68-75). CFSTI.

Computer programs were prepared to plot dynamic dose rate contours and maximum dose rate contours. A fallout dose rate subroutine was written for inclusion in an OCD general weapon effects model. These programs, which utilize the Miller fallout model, are extensions of programs generated earlier. Several improved computational procedures have been incorporated into the beta dosage program. The N-member chain concept has been developed for computing abundances of individual nuclides in fission product material. Negatron spectra for 175 nuclides have been built into the program and new beta spectra energy degradation data are used for weapon fallout. An option to calculate point dose on the circumference of a sub-surface disk and an option to generate SC4020 plots of point dose vs tissue depth have been incorporated. A gamma dosage program has been developed incorporating the N-member chain and many other procedures developed for the beta dosage program. (auth) (USGRDR)

**29006** (AE-353) DIFFUSION FROM A GROUND LEVEL POINT SOURCE EXPERIMENT WITH THERMOLUMINESCENCE DOSIMETERS AND $^{85}Kr$ AS TRACER SUBSTANCE. Gyllander, Ch.; Hollman, S.; Widemo, U. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Apr. 1969. 23p. Dep.

Within the framework of the IRIS-project (Iodine Research in Safety Project) an experiment to study diffusion at near-ground level was carried out on December 19, 1967, using $^{85}Kr$ as tracer element. The object of the experiment was to test the method using beta-sensitive thermoluminescence dosimeters under actual field conditions, and to study the initial dilution from a ground-level point source. The test area chosen was the Tranvik valley just south of Trobbofjaerden, an inland bay of the Baltic. Dose distributions were studied at two sections, 50 and 200 m, respectively, from the release point. At each level various dispersion parameters were experimentally determined and their conformity to normal distribution were calculated. Dilution factors valid for the center of the plume were related to the values reported in the literature. The experiment was made under ideal weather conditions above snow-free ground. (Sweden)

**29007** (KFK-930) THE RADIATION DENSITY OF KARLSRUHE NUCLEAR RESEARCH CENTER SURROUNDINGS AS A CONSEQUENCE OF LEAKAGE OF RADIOACTIVE MATERIAL INTO THE ATMOSPHERE. Heil, J. J.; Koenig, L. A. (Kernforschungszentrum, Karlsruhe (West Germany)). Feb. 1969. 25p. (In German). Dep.

A new calculation is presented of radiation exposure in the vicinity of the Nuclear Research Center, Karlsruhe, as a result of the release of radioactive substances into air. The exposure is exclusively caused by external irradiation. The calculation was based on a procedure which mainly refers to directly measurable meteorological data. Summarized are the emission data used for the calculations. The processed meteorological data are tabulated. Special attention was paid to the problem of the so-called calm which signifies in physics that no motion of the air can be detected with the available measuring equipment. A survey on the maximum gamma and beta dose contributions caused by the different institutions of the Nuclear Research Center is provided. The values for radiation exposure as well as comparative values of gamma dose measurements for various points are given. The new calculation of radiation exposure, with the help of a new calculating program, essentially confirmed the results obtained by previous calculations. This is, in particular, true for the statement that by the release of radioactive substances into air, radiation exposure does not exceed the few percent of natural radiation exposure and that it is practically impossible to determine it by measurements. (auth)

**29008** (ORNL-tr-2109) METEOROLOGICAL STUDIES OF TURBULENT DIFFUSION IN THE ATMOSPHERE. Polster, G. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). Translated for Oak Ridge National Lab., Tenn., from pp 160-73 of report JUL-543-ST. 18p. Dep. CFSTI.

The effects of strong warm air advection, cold air advection, and sinking processes and advection on the natural radioactivity emission from the earth were evaluated. Intensified turbulence was found in the fields of fronts and in cold air flows; weakened turbulence in warm air currents outside of front fields; phase shifts in the diurnal variation and at wind speed maxima under inversions, a type of low-level jet was detected. Turbulent diffusion in the atmosphere depends on many influences most of which are superimposed although at times, they predominate individually. Comparative measurements and observation are needed to evaluate different influences. (F.S.)

**29009** (RLO-2091-2) RADIOCARBON IN THE ENVIRONMENT. Fairhall, A. W.; Young, J. A. (Washington Univ., Seattle). [1968]. Contracts AT(45-1)-1776; AT(45-1)-2091. 21p. Dep. CFSTI.

The large perturbation produced in the level of $^{14}C$ in tropospheric $CO_2$ in 1963 to 65 left its mark in the terrestrial biosphere and is producing measurable changes in near-surface waters of the sea. It is clear that man has unwittingly initiated a geophysical experiment on a global scale. Provided that the present moratorium on atmospheric tests by the two major nuclear powers is continued, the 1961 to 62 nuclear tests will have provided an unparalleled opportunity for gaining increased insight into many of the processes taking place in our environment. (auth)

**29010** (SC-RR-68-903) CLOUD RISE FROM HIGH-EXPLOSIVES DETONATIONS. Church, H. W. (Sandia Labs., Albuquerque, N. Mex.). May 1969. 24p. Dep. CFSTI.

Data from a series of high-explosives trials of debris product cloud top heights versus time are presented. A brief comparison with some other experiments and with theory is made. It is concluded that so-called stabilization height can be predicted best as a function of explosive yield to the 0.25 power for chemical explosives in average atmospheres. (auth)

**29011** EXPOSURE RATES IN AIR DUE TO DEPOSITED FISSION PRODUCTS. Beck, H.; dePlanque, G. (Atomic Energy Commission, New York). Health Phys., 16: 784-5 (June 1969).

Polynomial matrix equation solutions to the $\gamma$-ray transport equation were utilized to investigate in detail the radiation field in air due to distributed $\gamma$-ray sources in soil. This investigation included calculations of the exposure rate, and the angular and spectral composition of the radiation field at various heights above the earth-air interface as a function of source energy and source depth distribution. Based on these extensive calculations new values are presented for the exposure rates at one meter above the ground due to known quantities of fission products deposited on the ground. Exposure rates for the most common isotopes occurring in worldwide fallout are given in tabular form. (auth)

**29012** ON THE STATIONARY VERTICAL DISTRIBUTION OF A WEIGHTLESS RADIOACTIVE SUBSTANCE IN THE SURFACE AIR LAYER. Yordanov, D. (Geophysical Inst., Sofia). Arch. Meteorol. Geophys. Bioklimatol., Ser. A, 17: 246-50 (Nov. 1968).

The stationary vertical distribution of a weightless radioactive substance is considered assuming horizontal homogeneity. A 2-layer exponential law for the height was taken for the vertical turbulent diffusion coefficient. The solution obtained was applied to the surface layer using the results of Monin and Obukhov on

its structure. The results of this analysis may be used at a homogeneously emanating earth surface as well as when there is a radioactive equilibrium between the Rn and its decay products. The problem of the availability of radioactive equilibrium in the surface layer is disputable especially with a strongly unstable stratification. Also the condition of a horizontal homogeneity is not always fulfilled, so that the results obtained in the present analysis must be used with care in certain instances. (BBB)

**29013** RADIOACTIVE NUCLEAR BOMB FALLOUT: A RELATIONSHIP BETWEEN DEPOSITION, AIR CONCENTRATION AND RAINFALL. van der Westhuizen, M. (Atomic Energy Board, Pretoria). Atmos. Environ., 3: 241-8(May 1969).

The importance of determining a relationship between deposited fallout, airborne concentration and rainfall is discussed. The methods of collection are described, and the relationship between deposited fallout and rainfall at Pretoria is examined. Using mean values, it was found that the monthly pattern of deposited fallout is approximately the same as that of the rainfall. It was further found that there is a non-linear relationship between the quarterly concentration of fallout in rainwater and the rainfall. Greenfield's model for scavenging of the air by rain is discussed briefly, and it is shown that the relationship between deposited fallout, air concentration and rainfall at Pretoria is consistent with this model. A non-linear relationship was found between the ratio of the concentration of fallout in rain and air, and the rainfall. The relationships between the different parameters are good enough to establish confidence limits for future measurements and to give an indication of the deposition if the air concentration and rainfall are known. (auth)

**29014** WORLD HEALTH CONSIDERATIONS IN AIRBORNE POLLUTION WITH SPECIAL REFERENCE TO RADIOACTIVE WASTES. Abbatt, J. D. (Dept. of National Health and Welfare, Ottawa). pp 1-4 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The cleaning of airborne radioactive wastes and the operational and developmental experience acquired from the management of these wastes are mentioned. The policy of requiring high-stack velocity discharge to ensure widespread dissemination of air pollution discharges, sources of air pollution, safety record of the nuclear industry, radiation protection guidelines, and the urgency of the general pollution problem are briefly described. (F. S.)

**29015** CHARACTERIZATION OF SODIUM SPRAY AEROSOLS. Nelson, C. T.; Koontz, R. L.; Silberberg, M. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. pp 45-50 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The consequences of pool and spray fires require evaluation in the safety analysis of liquid metal-cooled fast breeder reactors. Sodium spray fires are characterized by high temperature and pressure, produced during the rapid combustion of sodium in air. Following the initial energy release, some fraction of the reaction products are available as aerosols which follow the normal laws of agglomeration, growth, settling, and plating. An experimental study is underway at Atomics International to study the characteristics of high concentration sprays of liquid sodium in reduced oxygen atmospheres and in air. The experiments are conducted in a 31.5 $ft^3$ (2 ft dia. by 10 ft high) vessel, certified for a pressure of 100 lb/$in^2$ (gage). The spray injection apparatus consists of a heated sodium supply pot and a spray nozzle through which liquid sodium is driven by nitrogen pressure. Spray rate and droplet size can be varied by the injection velocity (nozzle size, nitrogen pressure, and sodium temperature). Aerosols produced in 0, 4, and 10 vol. % oxygen environments have been studied. The concentration and particle size distribution of the material remaining in the air after the spray injection and reaction period are measured. Fallout rates are found to be proportional to the concentration of aerosol which remains airborne following the spray period. (auth)

**29016** MODELLING CHARACTERISTICS OF AEROSOLS GENERATED DURING LMFBR ACCIDENTS. Koontz, R. L.; Nelson, C. T.; Baurmash, L. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. pp 51-61 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

Studies being conducted to develop experimental information and analytical methods which characterize the release and transport of effluents generated during major Liquid Metal Fast Breeder Reactor (LMFBR) accidents are described. Experiments were conducted in a laboratory test chamber to study the behavior of oxidized sodium released from a sodium pool fire at concentrations up to 60 $\mu g/cm^3$. Various quantities of burning sodium have been dispersed in various oxygen environments in a 6-ft high chamber, 40 $ft^3$ ($1.13 \times 10^6 cm^3$) in volume, with a total surface area of $10^5$ $cm^2$ and a floor area of 6260 $cm^2$. In all experiments, measurements are made of the airborne concentration and particle size distribution versus time, the mass and activity deposition rate on the floor and walls, the total amount of activity and mass deposited on the walls and floor, and the initial and remaining quantity of mass in the burn pot. Deposition samples from the floor and at several heights above the floor showed equal amounts of mass, and thus demonstrated "stirred" conditions. The conclusions derived from these experiments are: (1) As more aerosols are released into the chamber, the time for clearing the air decreases. The particle size distribution increases to larger maximum sizes as the mass of material released is increased, regardless of the shape of the aggregate (chains or spheres). The relation between the maximum radius and released mass concentration has been found to be approximately $r = \rho_R\ 0.4$, where $\rho_R$ is in $\mu g/cm^3$ and r is the maximum mass mean radius in microns. (2) Wall plating rates indicate that a higher deposition velocity occurs with increase in the airborne concentration, which is associated with higher temperature gradients. (3) The initial size of the released sodium oxide is log normal, with a mass median diameter of ~1.0 $\mu m$ and a geometric standard deviation of 2.33. (4) The experimental results described in this paper have been fitted by an empirical mass model. This model appears to describe the observed spatial and temporal characteristics of the aerosols sufficiently well for use in reactor safeguards evaluations. (auth)

**29017** THE CHARACTERIZATION OF $UO_2$ AEROSOLS BY AERODYNAMIC PARAMETERS. Baurmash, L.; Nelson, C. T.; Koontz, R. L. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. pp 63-76 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

Information on the behavior of $PuO_2$ aerosols is required for the analysis and design of safeguards for fast breeder reactors. Experimental investigations of $U_3O_8$ aerosols (as a simulant for $PuO_2$) produced by arc vaporization of $UO_2$-stainless steel mixtures in air were conducted, and the particle characteristics of the aerosols studied as a function of initial concentration and time. The increasing complexity of the three-dimensional, chain-like, multibranched agglomerates which are produced in increasing number with prolonged aging has been investigated by electron microscopy. It was evident that characterization of the aerosol particle size distribution could not be performed by microscopic examination, since the effective size of the agglomerate was difficult to determine. The spatial and temporal distribution of $U_3O_8$ aerosols was studied in a 40 $ft^3$ test chamber. Measurements were obtained for the mass concentration and aerodynamic particles size of the airborne material, the settling rate on the floor of the test chamber, and the deposition rate on the wall, all as a function of time. It was found that the removal functions were related to the aerodynamic particle size of the aerosol, rather than to an optically measured "size." The particle size of the aerosols was characterized by both the settling velocity of the released mass and the round-jet cascade impactors. Both methods yielded similar results. Using the settling times of the airborne material, it was possible to relate size and concentration. The concentration was proven to be homogeneous. Mixtures of aerosols produced by vaporizing $UO_2$-stainless steel in air and burning liquid sodium simultaneously were also studied. Both materials agglomerated together to form a complex branched aggregate which settled to the floor at a rate proportional to the combined mass concentration. Analyses of cascade impactor data show that the aerodynamic median diameter increases to a maximum value as a function of the released materials. The material collected on each stage revealed that the iron, sodium, and uranium oxides have identical distribution patterns. Complete characterization of the complex behavior of such mixed aerosols can only be made by the use of well-calibrated impactors and microchemical techniques. (auth)

**29018** THE KARLSRUHE RESEARCH PROGRAM ON NUCLEAR AEROSOLS AND ITS RELATION TO THE PLUTONIUM HAZARD OF FAST SODIUM REACTORS. Schikarski, W. (Kernforschungszentrum, Karlsruhe, Ger.). pp 77-91 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The Karlsruhe Aerosol Research Program was started in 1967 at the Nuclear Research Center Karlsruhe to study nuclear aerosols which may be generated in nuclear accidents. In particular, aerosols from accidents in fast reactors, their processes of generation, transport and impairment in reactor buildings are under investigation. The test facility used for the investigation of nuclear aerosols (called TUNA) is described together with the various steps of the experimental program. Theoretical analysis of the possible accidental plutonium release from fast reactors has shown the importance of the problem. The aspects of plutonium release via formation of aerosols are discussed, particularly in respect to the uncertain or unknown parameters and number involved. The conclusions drawn from these considerations which led to the present outline of the Karlsruhe Research Program on Nuclear Aerosols are discussed. The first results from experiments on $UO_2$ aerosols produced under simulated accident conditions by the exploding-wire technique are also given. (auth)

**29019** $PuO_2$-$UO_2$-Na AEROSOLS PRODUCED BY VAPORIZATION OF FAST REACTOR CORE MATERIALS. Horn, F. L.; Castleman, A. W. Jr. (Brookhaven National Lab., Upton, N. Y.). pp 93-115 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

A hypothetical accident for fast reactors predicts expulsion of sodium coolant from the core, gross melting and vaporization of fuel into a containment vessel which may contain air or an inert gas for safety reasons. The vaporized fuel subsequently condenses into an aerosol composed of $PuO_2$ and $UO_2$ mixed with Na. The characteristics of these aerosols were studied by vaporizing fuel and sodium into various atmospheres to simulate accident conditions. In all atmospheres, the individual $PuO_2$ and $UO_2$ particles formed are cubic in shape and range in size from 40 to 400 Å on an edge. Initially, these particles rapidly coagulate into chain and cluster aggregates measuring 0.05 to 0.3 μm in equivalent diameter. In humid air, the sodium oxide forms spheres and clusters of spheres with an initial count median diameter (CMD) of 0.17. However, in dry nitrogen the sodium shapes are more irregular and have a 0.30-μm initial CMD. The coagulation constant for $PuO_2$ in dry nitrogen ranges from $3 \times 10^{-9}$ to $9 \times 10^{-10}$ $cm^3$/sec during the 24 hours after generation. At a mass concentration of 22 mg Pu/$m^3$, a typical initial CMD for $PuO_2$ is 0.14 μm with a geometric standard deviation of 2.6. The mass concentration decreases rapidly with time but tends to reach a "stable" value of 10 μg Pu/$m^3$ after many hours. The combined aerosols of $PuO_2$, $UO_2$, and Na produce fairly constant size distributions depending upon the atmosphere in which they are formed. These agglomerates are composed of twisting chains of cubic shaped particles into which are incorporated sodium spheres and clusters. Dry nitrogen atmospheres produce agglomerates with a CMD of 0.6 to 0.8 μm, while humid air produces much smaller agglomerates having a CMD of 0.25 to 0.39 μm. A CDC 6600 computer was used to integrate numerically the coagulation relationships formulated by Smoluchowski, with terms added to account for particle formation and settling. Using the experimental data on the particle size distributions and the aerosol number density as a function of time, agglomeration coefficients were evaluated. In addition, the time dependence of the total airborne mass concentration was evaluated by integrating the product of the number density and particle density over all values of the particle radii. (auth)

**29020** AIRBORNE RELEASE OF PARTICLES IN OVERHEATING INCIDENTS INVOLVING PLUTONIUM METAL AND COMPOUNDS. Schwendiman, L. C.; Mishima, J.; Radasch, C. A. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. pp 117-31 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

Ever-increasing utilization of nuclear fuels will result in wide-scale plutonium recovery processing, reconstitution of fuels, transportation, and extensive handling of this material. A variety of circumstances resulting in overheating and fires involving plutonium may occur, releasing airborne particles. Observations from a study in which the airborne release of plutonium and its compounds was measured during an exposure of the material of interest containing plutonium to temperatures which may result from fires are described. Aerosol released from small cylinders of metallic plutonium ignited in air at temperatures from 410 to 650°C ranged from $3 \times 10^{-4}$ to $5 \times 10^{-6}$ wt %. Particles smaller than 15 μm in diameter represented as much as 0.03% of the total released. Large plutonium pieces weighing from 456 to 1770 g were ignited and allowed to oxidize completely in air with a velocity of around 500 cm/sec. Release rates of from 0.0045 to 0.032 wt % per hour were found. The median mass diameter of airborne material was 4 μm. Quenching the oxidation with magnesium oxide sand reduced the release to $2.9 \times 10^{-4}$ wt % per hour. Many experiments were carried out in which plutonium compounds as powders were heated at temperatures ranging from 700 to 1000°C, with several air flows. Release rates ranged from $5 \times 10^{-4}$ to 0.9 wt % per hour, depending upon the compound and the conditions imposed. The airborne release from boiling solutions of plutonium nitrate was roughly related to energy of boiling, and ranged from $4 \times 10^{-4}$ to $2 \times 10^{-1}$% for the evaporation of 90% of the solution. The fraction airborne when combustibles contaminated with plutonium are burned is under study. The data reported can be used in assessing the consequences of off-standard situations involving plutonium and its compounds in fires. (auth)

**29021** BEHAVIOUR OF RADIOIODINE IN GASEOUS EFFLUENTS. Barry, P. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 133-6 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

Because of the different chemical forms in which radioiodine occurs in the gaseous state, it is important when designing efficient filters to know the chemical forms which may be present in the effluent gases when various operations are being carried out and to know the effect of different gaseous environments on the filtration efficiency. To obtain this information it is necessary to have available reliable means of characterizing different chemical forms and to sample gaseous effluents when these operations are being carried out. The use for identifying molecular iodine of metallic screens in a multicomponent sampling pack in different gaseous environments is described. Using multicomponent sampling packs, the fractionation of iodine nuclides between different chemical forms was measured in the effluent gases escaping from an in-pile test loop in which the fuel was deliberately ruptured by restricting the flow of coolant. Sequential samples were taken for six hours after the rupture and it was possible to follow during this period the individual behaviors of $^{131}I$, $^{133}I$ and $^{135}I$. Simultaneous samples were also obtained of the noble gases in the effluent gas stream and of the iodine nuclides in the loop coolant. Similar experiments have been carried out with a view to characterizing the different chemical behavior of radioiodine as it is released from a variety of operations in the nuclear industry including the cutting of fuel sections in metallurgical examination caves and an incinerator. (auth)

**29022** METHYL IODIDE FORMATION UNDER POSTULATED NUCLEAR REACTOR ACCIDENT CONDITIONS. Kircher, J. F.; Barnes, R. H. (Battelle Memorial Inst., Columbus, Ohio). pp 137-62 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The formation of methyl iodide under conditions of postulated nuclear reactor accidents is discussed. Although thermodynamic calculations indicate the equilibrium methyl iodide concentrations would be quite low, calculations based on a simple kinetic scheme involving reaction between small hydrocarbon species and iodine indicate that concentrations higher than equilibrium can occur during the course of the reaction. Such calculations were performed over a wide range of initial species concentrations and a range of temperatures representative of some reactor accident situations. These calculations suggest that little methyl iodide would be expected within the core volume where temperatures are maximum. As the gas leaves the core volume and expands into the plenum region, it cools and the concentration of methyl iodide increases. At the intermediate temperatures which might characterize this region, the formation of methyl iodide from thermally induced reactions could reach its maximum rate. The gas continues to cool, however, and it is probable that by the time it leaves the plenum region it has cooled to the point where thermally induced reactions may be of little importance. Although the thermally induced reactions will become slower as the gas expands and cools, the radiation-induced reactions will not be slowed to the same extent. The gases leaving the core carry fission products and hence a radiation source is available to initiate reaction by a temperature-independent process. An investigation of the radiation chemical formation and decomposition of methyl iodide in the presence of steam suggests that radiation-induced methyl iodide formation will generally

be rapid under the postulated accident situations. Thus, in the plenum region where thermal reactions have become slow, the radiation-induced reaction can still proceed and may well become the dominant factor. The same situation probably pertains as well to the containment region. (auth)

**29023** DIRECT MEASUREMENT OF AIR DENSITY IN THE 30 TO 60 km REGION BY BETA-RAY FORWARD SCATTERING. Sellers, Bach (Panametrics, Inc., Waltham, Mass); Ballard, Harold N.; Izquierdo, Miguel. Int. J. Appl. Radiat. Isotop., 20: 341-51(May 1969).

A system based on the forward scattering of low-energy beta particles was incorporated into a parachute-borne sonde. Density data obtained through use of this system are presented and compared with density values obtained at essentially the same time by a standard method which utilized measured temperature and pressure values. By taking into account possible differences in the determinative altitudes of the two systems, the two methods yielded similar results in the 30 to 35 km region; the beta-ray derived densities were, however, higher by about 40 to 50% in the 45 to 60 km region. Although several possible explanations for this difference are considered, it is pointed out that the exact reason is not known. Further flights are anticipated. (auth) (UK)

**29024** AN ATTEMPT TO TRACE THE MONSOON FLOW USING NATURAL RADON. Rama (Tata Inst. of Fundamental Research, Bombay). Indian J. Meteorol. Geophys., 19: 167-70 (Apr. 1968).

Measurements of Rn concentration in air over the Arabian Sea and the Indian Ocean were made in attempts at identification of southeast tradewinds and of continental air in the monsoon current. A controversy over the Indian summer monsoon centers about whether the monsoon current is constituted primarily of the deflected southeast trades from the Indian Ocean or of air primarily from the north African continent. The maritime southeast trades should be very poor in Rn, while continental air from north Africa should be comparatively very rich in Rn. It should, therefore, be possible to discern which one of the two constitutes the monsoon current over the Arabian Sea. In order to test the validity of this idea and the feasibility of the proposed method, exploratory measurements were made over the Arabian Sea and the Indian Ocean. These measurements demonstrated that the concept is basically correct and the method suitable for distinguishing the maritime southern airmasses from the continental north African airmasses when and if they intrude over the Arabian Sea during the monsoon season. The measurements were made aboard the State of Bombay and S. S. Mozaffari. During the cruise the Rn concentration stayed at about 30 to 35 dpm/$m^3$ from Bombay to a location 5°N in the central Arabian Sea, then suddenly dropped to about 3 dpm/$m^3$ and stayed constant at this value in the entire region of S-E tradewinds. The Rn concentrations close to the Arabian and Somalia coast ranged between 50 and 160 dpm/$m^3$. The concentrations near the Bombay coast ranged between 40 and 160 dpm/$m^3$ in the first week of March 1966. Radon is continuously exhaled from the land surface from where it is transported upwards by convective and mixing processes. (BBB)

**29025** BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY. NO. 51, OCTOBER–DECEMBER 1967. Taiki Hoshano Kansoku Seiseki, No. 51, 1-63(Oct.-Dec. 1967). (In Japanese).

Measurements of a temporary standard sample of $U_3O_8$ were taken at several Japanese locations. Measurements, taken at fixed times, of the radioactivity of airborne dusts and rain at various Japanese stations are given. (G.M.C.)

## Mineralogy and Exploration

**29026** USE OF CONTACT MICRORADIOGRAPHY METHOD FOR URANIUM ORE INVESTIGATION. Varga, V. V. At. Energ. (USSR), 26: 427-31(May 1969). (In Russian).

Results of investigation of some types of uranium ores are represented. These ores cannot be studied by a reflective microscope because the reflectivity of uranium minerals coincides with that of associated minerals. Investigation of hydrothermal and epigenetic ores shows that this method, widely adopted in biology and medicine, may also be successfully applied to uranium ores. This method contributes to better analysis of uranium minerals, to determination of pitchblende oxidation degree, and to revealing structure and texture details of ores. The method of contact microradiography is described and some practical recommendations related to sample thickness, and x-ray wavelength and exposure duration are given. The uranium ore investigations prove the simplicity, rapidity, and cheapness of this method. (auth)

**29027** DISTRIBUTION OF URANIUM, THORIUM, AND POTASSIUM IN THE LAVAS FROM THE DANAKIL (ETHIOPIA), MAGMATIC INCIDENCES. Cheminee, Jean-Louis (Faculte des Sciences, Paris). Compt. Rend., Ser. D, 268: 1675-8(Mar. 31, 1969). (In French).

In Danakil, the correlations existing between U, Th, and K indicate, for these elements, a different geochemistry according to the family of rocks. Some process such as gaseous transfer has played an important role in the general magmatic evolution of the chain of the Erta Alé. The origin of the rhyolites of that chain are bound by the fusion of the crust by the primary basaltic magma. (tr-auth)

## Oceanography

*Refer also to abstract 29466.*

**29028** (RLO–2091-3) RADIOCARBON IN THE SEA. Progress Report, August 15, 1968–May 1, 1969. Fairhall, A. W. (Washington Univ., Seattle. Dept. of Chemistry). Contract AT-(45-1)-2091. 16p. Dep. CFSTI.

The sampling programs for radiocarbon in seawater are discussed. Carbon-14 concentration in $CO_2$ extracted from surface waters of the Atlantic, Indian, and Pacific Oceans is given. The itinerary of the research ships is outlined. (J.C.W.)

**29029** RADIOISOTOPES AND OCEANOGRAPHY. Keller, G. H. (Atlantic Oceanographic Labs., Miami, Fla.). Isotop. Radiat. Technol., 6: 376-81(Summer 1969).

A brief review of the literature indicates that, although radioisotope methodology in oceanography is not yet extensive, significant developments have been made. Radioisotope methods have been used for making observations directly in the environment and for tagging and dating both water masses and sediments. Only prototype nuclear instruments have been, in general, used thus far, but results obtained with them indicate the feasibility of using such instruments for measuring current velocity, oxygen content, deposited-sediment density, suspended-sediment concentration, and the elemental compositions of bottom sediments. (auth)

**29030** $^{90}Sr$: CONCENTRATIONS IN SURFACE WATERS OF THE ATLANTIC OCEAN. Bowen, Vaughan T. (Woods Hole Oceanographic Institution, Mass.); Noshkin, Victor E.; Volchok, Herbert L.; Sugihara, Thomas T. Science, 164: 825-7(May 16, 1969).

From the large body of analyses of strontium-90 in surface waters of the Atlantic Ocean, annual average concentrations (from 10°N to 70°N) have been compared to those predicted. The data indicate higher fallout over ocean than over land and confirm the rapid rates of down-mixing shown by most studies of subsurface strontium-90. (auth)

## Seismology

**29031** (AD–683311) LONG PERIOD GRAVITY AND ACOUSTIC MODES OF THE LOP NOR THERMONUCLEAR EVENT OF JUNE 17, 1967. Tolstoy, I.; Herron, T. (Columbia Univ., Dobbs Ferry, N. Y. Hudson Labs.). Aug. 1968. Contract Nonr-266(84). 30p. (TR–139; CU–165-68-ONR-266-Phys). CFSTI.

Results obtained on the Hudson Laboratories long period microbarograph array for the Chinese thermonuclear explosion of June 17, 1967 are described. Of particular interest is the presence of a fast arrival, having a period of approximately 15 min and traveling with a speed of about 600 msec. This arrival is detected by beamforming techniques both for the short great circle path and for the long one. Also detected were 7- to 8-min periods traveling at 300 msec. (auth) (USGRDR)

**29032** INVESTIGATIONS OF THE EFFECT OF SHOCK ON NATURAL REMANENT MAGNETISM. Hargraves, R. B.; Perkins, W. E. (Princeton Univ., N. J.). J. Geophys. Res., 74: 2576-89(May 15, 1969).

At Meteor Crater, Arizona, shock pressures generated by impact apparently had no effect on the RM of samples of Moenkopi red beds collected at four sites around the rim of the crater. The mean direction (D = 346°, I = 21°, K = 6) after correction for bedding attitude and thermal demagnetization to 400°C is close to that of Moenkopi samples collected outside the crater and the value reported by other workers elsewhere in Arizona. At the Nevada Test Site of the Atomic Energy Commission: (1) the orientation of NRM of samples of Rainier tuff from around the site of an underground nuclear explosion is close to that of the local earth's field, suggesting remagnetization due to the shock; (2) the bulk susceptibility of the Hardhat granodiorite has been reduced by shock; and effect on remanence is detectable in the most intensely

shocked samples, but uncertainties in core-orientation and intrinsic instability of the rock preclude effective analysis of remanence directions. Intensity of RM of basalt subject to 10- to 100-kb pressure by artificial impact at Ames Research Center is reduced to ½ or ¼, with moderate change in direction. The intensity (and probably the orientation) of a viscous component acquired during shock is a function of the ambient field; it is largely erased by 50-oe af demagnetization. The intensity and orientation of RM in shocked and unshocked samples converge after 500-oe af demagnetization. (auth)

# ENGINEERING

## Nuclear Explosions

*Refer also to abstracts 29031, 29032, and 29474.*

**29033** (SC-DC-68-2467) CLOSE-IN AIRBLAST FROM BURIED ROW CHARGES. Vortman, Luke J. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1968. 38p. (CONF-690114-1). Dep. CFSTI.

From Meeting of the Highway Research Board Committee, MCE 1 Nuclear Principles and Applications, Washington, D. C.

In a study of close-in airblast from buried row charges, five airblast parameters were examined for ground-shock-induced peak overpressure, peak overpressure from venting gases, peak negative pressure, and positive and negative phase impulses. Data show that attenuation of each of these parameters with distance is a function of the temperature profile above ground, wind velocity, and blast diffraction around the edge of the mound through which the explosion vents. Attenuation with distance perpendicular to a row-charge detonation is also a function of the length of the row together with the distance at which measurements were made. (F.S.)

**29034** APPLICATION OF ABOVEGROUND RETORTING VARIABLES TO IN SITU OIL SHALE PROCESSING. Carpenter, Harry C.; Sohns, Harold W. (Laramie Petroleum Research Center, Wyo.). Quart. Colo. Sch. Mines, 63: 71-82(Oct. 1968).

Use of nuclear explosives for in situ retorting of oil shales is discussed on the basis of results obtained with an experimental model. An experimental retort has been built and operated at the Laramie Petroleum Research Center to study the retorting characteristics of material that might exist in a nuclear chimney. Studies have used mine-run shale containing pieces as large as 20 inches in 2 dimensions. If a nuclear explosion were used to fracture oil shale, predictions of what would take place can be made on the basis of experience in fracturing other rock types by this method. Presumably a large cylindrical chimney filled with broken oil shale would be formed. The broken material is expected to vary from sand-grain size to pieces several feet on a side. Theoretical studies indicate that pressure drop through the chimney should be low. Experience with the Laramie 10-ton retort showed that yields of 80% of Fischer assay can be attained when retorting oil-shale particles varying from small grains to pieces as large as 20 in. As much as one-third of the available energy was lost through the sides and ends of the above-ground retort. Recovery of these losses and the more efficient utilization of sensible heat that will be possible in the large chimney resulting from a nuclear explosion should reduce air requirements. Some carbonaceous residue in the spent shale may not be readily available for fuel; however, more efficient use of the energy that is available will reduce the fuel requirements. (BBB)

**29035** CALCULATION OF SHRINKAGE OF THE SALMON CAVITY. Wells, W. M. (Univ. of California, Livermore). J. Geophys. Res., 74: 2791-4(May 15, 1969).

A simplified analysis of cavity shrinkage for the cavity produced by the Salmon underground nuclear explosion in a salt dome is presented. In this analysis the plastic zone is assumed to be incompressible and yielding upon unloading is considered because the expansion pressure was high. Results are in reasonable agreement with measured shrinkage. (F.S.)

**29036** ARCHITECTURAL DAMAGE TO RESIDENTIAL STRUCTURES FROM SEISMIC DISTURBANCES. Nadolski, Michael E. (Univ. of California, Livermore). Bull. Seismol. Soc. Amer., 59: 487-502(Apr. 1969). (UCRL-71015(Rev. 2)).

Architectural damage to residential structures caused by seismic disturbances was examined to determine meaningful ground-motion damage criteria. Motion records were analyzed to give a response spectrum of building motions. Widely varying amounts of damage resulting from similar peak-particle velocities are explained by the building response envelope which combines the amplitude, duration, and frequency content of the ground motion. A correlation between existing damage and the absolute acceleration values is developed and a comparatively safe amplitude region is shown. A plot of damage complaints versus the pseudo absolute acceleration is presented as an effective damage prediction criterion. (auth)

## Facilities and Equipment

*Refer also to abstracts 29021, 29022, 29111, 29113, 29124, 29126–29143, 29985, 30001, 30171, 30188, 30453, 30457, and 30488.*

**29037** (ANL-7522) DESIGN AND APPLICATION OF CORROSION-RESISTANT HEATED TRANSFER TUBES FOR LIQUID METALS AND SALTS. Grosvenor, D. E.; Winsch, I. O.; Miller, W. E.; Bernstein, G. J.; Pierce, R. D. (Argonne National Lab., Ill.). Dec. 1968. Contract W-31-109-eng-38. 15p. Dep. CFSTI.

Pyrochemical processes under development at Argonne National Laboratory use liquid metals and molten halide salts as solvents to separate molten fuel materials from each other and from fission products. These solvents are moved between process vessels by pressure-transferring through resistance-heated transfer tubes operating at temperatures up to 850°C. The transfer tubes are J- or U-shaped and are fabricated from gun-drilled molybdenum-30 w/o tungsten bar stock. The tubes are shaped by hot-bending in a jig. A technique for joining two pieces of tubing was developed because of the limited overall length of tubing available. The transfer tubes are wrapped with resistance heaters, covered with insulation, and protected by steel shells. Temperatures are controlled by adjusting the voltages in the various heater circuits. (auth)

**29038** (BNWL-1052) DRY WHEEL CENTERLESS GRINDER FOR DEVELOPMENT LABORATORY USE. DeMeyer, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1969. Contract AT(45-1)-1830. 10p. Dep. CFSTI.

A grinding device was designed and constructed for glove box use as an inexpensive and simple means of making small reductions in the diameter of $PuO_2$–$UO_2$ pellets which are used in fuel elements. The device is used in dry grinding to eliminate pellet contamination. In combining the grinder with a Syntron rotary vibration feeder, 1200 to 1800 pellets per hour can be produced while removing 0.002 to 0.004 in. on the diameter. Diametral tolerance can be held to 0.0002 in. on a 0.200 in. diameter pellet. (F.S.)

**29039** (CONF-680649-1) A MULTIPLIER RULE FOR A FUNCTIONAL SUBJECT TO CERTAIN INTEGRO-DIFFERENTIAL CONSTRAINTS. Wittler, Manfred; Shen, C. N. (Rensselaer Polytechnic Inst., Troy, N. Y.). [1968]. 16p.

From 9th Joint Automatic Control Conference, Ann Arbor, Mich.

A problem in the optimal control of a nuclear rocket requires the minimization of a functional subject to an integral equation constraint and an integro-differential inequality constraint. A theorem giving first order necessary conditions is derived for this problem in form of a multiplier rule. The existence of multipliers and the arbitrariness of certain variations are shown. The fundamental lemma of the calculus of variations is applied. A simple example demonstrates the applicability of the theorem. (auth)

**29040** (JEN-182-DME/I-17) THE $UO_2$ PELLETS PLANT EXPERIMENTAL BACKGROUND OF THE ESTABLISHED PROCESS. Aparicio Arroyo, E.; Alonso Folgueras, J. A. (Junta de Energia Nuclear, Madrid (Spain). Division de Metallurgia). 1969. 55p. (In Spanish). Dep.

Uranium dioxide research and development at JEN and the construction of a plant to produce 10 tons/year of $UO_2$ pellets are described. The experimental background of the process and the advantages and risks in milling are discussed. Equipment including granulation devices, presses, and furnaces for binder removal and sintering are described. The parameters for raw materials such as origin, surface area, grain size, and O/U ratio are considered. Research methods other than controls for powder surface and size and pellet density are described. Further trends and first results in producing 3% enriched $UO_2$ pellets are reported. (F.S.)

**29041** (RD/B/N-1305) SOLID WEDGE FINITE ELEMENT FOR STRESS ANALYSIS. Hellen, T. K. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb. 1969. 15p. Dep. CFSTI. UK.

A wedge-shaped element containing fifteen corner and midside nodes suitable for use in three-dimensional structures is presented. The element has been incorporated in the CEGB general stressing system, called SAFE, and is designated EZ45. The element is expected to be used mainly in conjunction with the

solid brick element with twenty corner and midside nodes, currently available in SAFE and designated EZ60. (auth)

**29042** TUBULAR HEAT EXCHANGERS. Tennyson, Claudius (to English Electric Co., Ltd.). British Patent 1,152,034. May 14, 1969. Filed Aug. 12, 1965.

Reference is made to heat exchangers comprising a plurality of tubes disposed longitudinally within the heat exchanger vessel, each end of each tube being fixed to a tubeplate, with spacer rings arranged coaxially around at least some of the tubes, each spacer ring being in circumferential engagement with other tubes to maintain a predetermined spacing between the tubes. The tubes, with spacer rings, are secured in a bundle by straps, and the bundle is located in the heat exchanger vessel only by means of the tubeplates. Means may be included allowing for thermal expansion and contraction of the strap. Various spacer ring constructions are described, including the provision of aerodynamic profiling to offer as little resistance as possible to fluid flow. (UK)

**29043** γ-IRRADIATION PLANTS UTILIZING REACTOR FUEL ELEMENTS. II. Suckow, W. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Isotopenpraxis, 5: 41-5(Feb. 1969). (In German).

Recent irradiation plants utilizing fuel elements are described. Criteria for optimizing such plants, evaluation of the plants realized so far, and applications for the facilities are discussed. (auth)

**29044** INLAY LININGS IN REACTOR CONSTRUCTION. Mursic, M. (Versuchsabteilung der Linde AG, Lohhof, Ger.). Kerntechnik, 11: 231-2(Apr. 1969). (In German).

The fabrication of inlay linings for reactor vessels by the powder underlay strip welding technique is considerably simpler than the conventional welding technique in two layers. The prerequisites are resistance against corrosion and smooth crack-free weld seam with a notch-free transition. The required apparatus, the welding powder/strip combination, and the welding techniques are described. The lining material is Cr–Ni–Nb stainless steel. (auth)

**29045** EXPERIMENTAL RESEARCH ON THE STRESS STATES FOR RADIALLY SECTIONED CYLINDRICAL VESSELS WITH INTERNAL PRESSURE. Nerli, Giovanni; Rosa, Umberto (Univ., Pisa, Italy). Ing. Nucl., 9: No. 6, 19-32(Nov.-Dec. 1968). (In Italian).

Studies were made of the stress state produced in an elastic field by internal pressure in a cylindrical vessel. Design procedures and construction of plastic models are described. Effects of test pressures and selection of design criteria for reinforced openings in pressure vessels are discussed. (tr-auth)

**29046** APPARATUS FOR PLANNING AND MONITORING THE TREATMENT OF TUMORS BY RADIATION. Alderson, Samuel W. (to Alderson Research Labs., Inc.). British Patent 1,152,442. May 21, 1969. Filed Apr. 29, 1966.

A method and apparatus for determining the radiation dose distribution required for the treatment of malignant tumors are described. A phantom is matched precisely to a patient and is subjected to an external source of therapeutic ionizing radiation, so that the dose distributions measured within the phantom will be the same as those which would be found within the corresponding patient. (W.H.K.)

**29047** DEVICE FOR DRIVING A SHUTTER FOR A RADIATION IRRADIATOR. Tsuzuki, Tadaichi (to Tokyo Shibaura Electric Co.). Japanese Patent 1969-852. Jan. 14, 1969. Filed June 19, 1965.

A device for operating a shutter for an irradiator is described, that employs the motion of a crank. By choosing the length of the arm of the crank, the distance of stroke of the linear shutter-movement can be varied as desired. The mechanism is resistant to shock due to cam rollers being employed between the shutter block and the crank arm. Other advantages are superior reproducibility of the position of a shutter, and exact timing of the irradiation, and rapid motion of a shutter. The shutter driving device includes: a radiation source, the container for the radiation source, top-end open hole cut in the upper part of the shield in which the container is placed, a vertically moving shutter block which is set on top of the shield, a mechanism which pushes the source container, a crank, cam rollers, and a bracket, located between the power supply and the shielding shutter. In moving the shutter vertically, the arm of the crank is rotated in a half-circle. (NSA of Japan)

**29048** ELECTRON IRRADIATION DEVICE. Mizusawa, Kenichi (to Nissin Electric Co.). Japanese Patent 1969-4800. Feb. 21, 1969. Filed Aug. 23, 1965.

An electron irradiation device is described in which the field of electrons is uniform. The higher intensity of electrons at the edge of an electron field can be averaged with the rest of the field, increasing the use of available electrons. An electron beam is spread at the beam exit to give a spread of electrons. The intensity is higher at the edge of the resulting field plane. The electron-absorbing grid, corresponding to the higher-intensity edge of the field, is installed at a position near the object to be irradiated to absorb the excess electrons to give a flattened intensity distribution. (NSA of Japan)

**29049** SAMPLE CAPSULE CONTROLLED IN TEMPERATURE USING THE THERMAL RESISTANCE OF A VACUUM. Hayashi, Takao (to Japan Atomic Energy Research Inst.). Japanese Patent 1969-1398. Jan. 22, 1969. Filed Oct. 8, 1964.

A method for controlling the temperature of a sample capsule placed near the reactor core is described. The method uses the thermal insulation of a vacuum and has the following advantages: control of the temperature during reactor shut-down and ease in lowering the temperature by breaking the vacuum, to keep the integrity of the contained sample. The capsule, within a nuclear reactor, is surrounded with an outer casing; the space between is led outside the reactor. This space is either filled with a gas or evacuated to a desired degree in order to control the temperature of the capsule. The method proposed can be used in a combination with other conventional means of temperature control. (NSA of Japan)

**29050** SAMPLE CAPSULE. Hirasawa, Yoshinari (to Mitsubishi Atomic Power Ind., Inc.). Japanese Patent 1969-1399. Jan. 22, 1969. Filed Oct. 21, 1965.

A sample capsule is described for irradiating a sample in a nuclear reactor. The advantages are the following: secure holding of a sample in the capsule; improved contact of the sample with the inner wall of the capsule; reduction in thermal stress of the sample; easy construction of the capsule; and low fabrication cost. A sample material having parallel sides such as a cube, is inserted between the inner surfaces of the corresponding sides of the capsule to hold the sample tightly. The distance between the two sides of the capsule is smaller than the corresponding thickness of the sample material. The remaining sides of the sample are a short distance away from the corresponding inside of the capsule leaving room to accommodate the thermal expansion of the sample material. (NSA of Japan)

**29051** HARWELL CERAMICS CENTRE. London, United Kingdom Atomic Energy Authority, 1969. 12p.

An illustrated pamphlet is presented stating the aims of the Centre, current interests, equipment available, processes under development, and means of contacting the Centre. (UK)

**29052** METHOD FOR PURIFYING LIQUID METAL. Sagawa, Norihiko (to Hitachi Ltd.). Japanese Patent 1969-1052. Jan. 18, 1969. Filed Jan. 21, 1966.

A method is described for purifying liquid metals, e.g., sodium, potassium or their compounds. The method has the advantages of regeneration of the purifying device and of its easy maintenance. From the main path of liquid metal, such as the primary coolant loop in a nuclear reactor, another loop branches off. Both ends of the latter loop connect to the main path. A trap is installed in each half of the loop. Impurity oxides in the molten metal are trapped in the first trap after precipitation. After this trap has been filled with the impurities, the flow from the main path into the purifying circuit is stopped, and flow is through the loop. The temperature of the first trap is raised, and the trapped impurity oxide is dissolved into the flowing liquid metal; the dissolved impurity is then trapped and collected in the second trap kept at a lower temperature of impurity precipitation. (NSA of Japan)

**29053** PELLET SECTIONING VISE (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1854).

3 drawings.

The vise used to hold pellets to be sectioned by the equipment described in CAPE-1855 is described. Pellet samples are clamped into the vise and manually applied to the Syntron polisher in preparation for metallographic analysis. (For details see TID-4100 Suppl. 53.) (F.S.)

**29054** SYNTRON POLISHER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1855).

3 drawings.

A small saw is described for metallographic sample cutting. The saw is powered by a small Bodine electric motor with gear reduction which results in a no-load speed of 170 rpm on the blade spindle. The low rpm prevents scattering of particles and dusts from the sample and in case the blade breaks, the fragments will not be hazardous. The blades travel through a sponge wetted with a suitable coolant such as silicone oil, tetradecane or water to

minimize airborne contamination during cutting. The saw is operated in a glove box. (For details see TID-4100 Suppl. 53.) (F.S.)

**29055** DOUBLE-WALLED HEAT EXCHANGER. Kestemont, Lucien (to EURATOM). British Patent 1,153,068, May 21, 1969. Priority date Sept. 6, 1965, Belgium.

A double-walled heat exchanger is described which has plates made of good heat conductor material placed in the space between the two walls. The plates are attached to the two walls to conduct heat between the walls. The space between the walls is filled with gas. A detector is provided to find any leaks which would be indicated by contamination of the filling gas. Means are provided for circulating the filling gas through the detector. (F.S.)

**29056** SCATTERING FOIL DEVICE FOR HIGH ENERGY ELECTRON BEAM THERAPY. Okumura, Yutaka (Aichi Cancer Center Research Inst., Japan); Kitagawa, Toshio. Nippon Igaku Hoshasen Gakkai Zasshi, 27: 677-81(Sept. 1967). (In Japanese).

A scattering foil device was evaluated, using high energy electron beam therapy with a betatron operating in the 4 to 31 MeV energy range. Desirable isodose curves were obtained, and the high-intensity portion of the 90% isodose curve was adjusted in position and width, with a surrounding flat 70% isodose curve. This method simplified the setting up of treatment, avoided the formation of secondary radiation, preserved a skin-sparing effect, and was found to be advantageous in treatment of regionally invasive tumors where a homogeneous dose distribution was less desirable. Details in English will be published elsewhere. (NSA of Japan)

**29057** CALCULATION OF POST-YIELD STRESSES AND SHAKEDOWN LOADS FROM STRAIN GAUGE READINGS. Crisp, R. J. (Central Electricity Generating Board, Berkeley, Eng.). J. Brit. Nucl. Energy Soc., 8: 116-22(Apr. 1969).

A computer program, SCAL, was written to calculate post-yield stresses and shakedown loads, in a bi-axial stress field, from strain gauge readings. Details are given of the theory and assumptions used in the program and the method of solution adopted. The program was used to examine a nozzle in a model of a nuclear pressure vessel, and this is discussed in some detail as an example of its application. (auth)

**29058** APPLICATION OF IMPREGNATED CHARCOALS FOR REMOVING RADIOIODINE FROM FLOWING AIR AT HIGH RELATIVE HUMIDITY. Adams, R. E.; Ackley, R. D.; Shields, R. P. (Oak Ridge National Lab., Tenn.). pp 387-402 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

In addition to elemental iodine ($I_2$), methyl iodide ($CH_3I$) constitutes a recognized species of airborne radioiodine. Certain commercial iodized charcoals have the capability of extracting via isotopic exchange the $^{131}I$ of $CH_3{}^{131}I$ transported in air and steam-air streams, even at rather high relative humidities. This work has been extended to include a greater variety of charcoals and to determine the effects of both normal and abnormal operating conditions. Several types of iodized charcoal have exhibited $CH_3{}^{131}I$ (actually, $^{131}I$ of $CH_3{}^{131}I$) removal efficiencies of >97% for a 2-inch depth at room temperature and 65% relative humidity (R.H.); the analogous efficiencies at 90% R.H. ranged from 16 to 99%. In steam-air tests, the five types of iodized charcoal tested yielded $CH_3{}^{131}I$ removal efficiencies of ≥90% for a 2-inch depth provided the relative humidity did not greatly exceed 90%. The question as to whether the iodizing process reduces the capacity for fission-product $I_2$ to an unacceptable level was found not to represent a problem at room temperature and at 98% R.H. However, the condition of 100% R.H., together with extensive flooding of the charcoal, resulted in appreciable lowering of the $I_2$ removal efficiency. An apparent lowering in efficiency was also observed when the $I_2$ inlet concentration was decreased below $10^{-2}$ mg/m$^3$. The effect of weathering on impregnated charcoals is being investigated. Results obtained indicate a small rate of decrease in $CH_3{}^{131}I$ removal efficiency for iodized charcoal exposed to flowing purified and humidified air and a somewhat greater rate of decrease for charcoal subjected to humidified air containing traces of organic impurities. The stability of iodized charcoals to elevated temperatures was investigated by labelling their impregnant(s) with $^{131}I$ and then measuring any losses of $^{131}I$ during successive heating periods at progressively higher temperatures. Five types of iodized charcoal were observed stable at 150°C, while three were still reasonably stable at 200°C. At 250°C all exhibited sizable $^{131}I$ losses. A program for measuring charcoal ignition temperatures under both laboratory and reactor conditions is in progress. In laboratory tests, ignition temperatures for iodized charcoals of 365°C and higher have been observed, depending on the charcoal type. In related work, in-pile, the ignition temperature of iodized charcoal was noted to decrease, presumably a result of radiation effects. (auth)

**29059** EFFICIENCY OF IMPREGNATED CHARCOAL TRAPS FOR FISSION PRODUCTS RELEASED IN A SWIMMING-POOL REACTOR ACCIDENT. Dadillon, J. (CEN, Cadarache, France). pp 365-86 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968. (In French).

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

It is a well-known fact that any significant increase of humidity in a reactor containment may considerably reduce the efficiency of iodine filters. In view of the interesting laboratory work carried out in the last few years, particularly on different techniques of charcoal impregnation, it was decided to induce the melt-down of a fuel element in a swimming-pool reactor—by means of a power transient—in order to study the behavior of the iodine released above the water in filters containing impregnated charcoal of different types. The fraction of iodine not retained in the reactor pool (representing about $1/_{20000}$ of all the iodine released by the fuel) is in three forms. Relative humidity reached 100% in the containment, and in these conditions the decontamination factor of a 5-cm carbon layer varied between $2 \times 10^4$ and $7 \times 10^6$, depending on impregnation, for the iodine form most easily trapped, while remaining consistently below 5 for the most penetrating form. (auth)

**29060** SEPARATION OF RADIOACTIVE XENON AND KRYPTON FROM OTHER GASES BY USE OF PERMSELECTIVE MEMBRANES. Rainey, R. H.; Carter, W. L.; Blumkin, S.; Fain, D. E. (Oak Ridge National Lab., Tenn.). pp 323-42 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

A process is being developed for separating radioactive xenon and krypton from other inert gases or from air by use of a dimethyl silicone rubber membrane. This separation is based on the solubilities of the gases in, and their rates of transport through, the membrane. Applications include the removal of the noble gases from: the air within a reactor containment building, e.g., after an accidental release of fission products; the off-gas from a processing plant for spent reactor fuels; and the gas that blankets nuclear reactors, especially those which continuously vent volatile fission products, such as the molten salt or the sodium-cooled breeder reactors. The transport of a gas through a permselective membrane is measured in terms of a permeability factor, which is defined as the product of the thickness of the membrane and the flow rate of gas through the membrane per unit area of membrane and per unit differential partial pressure of the gas across the membrane. The relative values of these factors for xenon, krypton, oxygen and nitrogen through dimethyl silicone rubber are 203, 98, 60 and 28, respectively. The factors were about one-half these values when the membrane was mounted between two Dacron mats for physical support. The permeability factors decreased, but the stage separation factors, the ratio of the concentrations of the gases in the product and reject streams, increased, as the pressure across the membrane increased or as the temperature decreased. The stage separation factor was also larger with countercurrent than with cocurrent flow of the gases through the membrane unit. Attempts to correlate experimental with computed separation factors have been partially successful. Efforts are under way to improve the membrane and to design a compact, reliable multimembrane stage unit. Preliminary calculations of the cost of removing and concentrating the noble gases by a cascade of permselective membrane units indicate that this method is economically competitive with other proposed processes. (auth)

**29061** SENSITIVE METHOD OF MEASURING THE EFFECTIVENESS OF HIGH-EFFICIENCY FILTERS BY MEANS OF URANIN AEROSOL. Pradel, J.; Brion, J. (CEN, Fontenay-aux-Roses, France). pp 279-89 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968. (In French).

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

Measurements of the effectiveness of high-efficiency filters are generally not very sensitive because of the quality of the filters that have to be studied. The fraction of the test aerosol which passes through the filters is very small, and experimenters often have to release heavy concentrations of aerosol upstream in order to get measurable concentrations downstream

of the filter—a technique which tends to produce coagulation. A method is described that utilizes a test aerosol whose average particle size corresponds to the maximum permeability of the high-efficiency filters. Accordingly the purification factors determined by this method are 10 to 100 times smaller than those yielded by conventional techniques such as the method using monodispersed DOP. The technique of assaying the samples, based on fluorescence, further increases the sensitivity of the method. The test aerosol concentrations required upstream of the filters are very small (10 $\mu g/m^3$), and installations of large capacity can be monitored with equipment of comparatively small size and weight. A description of the method used and results obtained with plane filter samples and filter elements are given. The results obtained with the new method are compared with those given by monodispersed DOP. (auth)

**29062** ECONOMICS OF SOME TYPES OF ABSOLUTE FILTERS. Linder, P. J.; Skogulf, H. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 221-6 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The cost of air-cleaning filters is determined by the purchase price of the filter and its mean life. If filter changes are not caused by a high level of activity, the increase in pressure drop will make a filter change necessary. In the latter case the dust-holding capacity of the filter determines the interval between changes. A number of different filters have been compared in this respect using atmospheric aerosols and a significant difference in cost has been observed. (auth)

**29063** OCTENNIAL HISTORY OF THE DEVELOPMENT AND QUALITY OF HIGH-EFFICIENCY FILTERS FOR THE US ATOMIC ENERGY PROGRAM. Gilbert, H. (Atomic Energy Commission, Washington, D. C.). pp 227-34 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

Two facilities are operated for the US Atomic Energy Commission in its program to ensure the uniform quality of commercially manufactured high-efficiency particulate filters. The filter-testing program was started in January 1960 after it was realized that the commercial fire-resistant product incorporated deficiencies of manufacture. The record of testing for quality assurance by the two facilities and an analysis of factors governing the quality of filters are presented. The analysis is complemented with a description of efforts, made in the course of the filter testing, to improve the design of the filter for efficiency and reliability. The fire-resistant (HEPA) filter of 1959 was inadequate. The inadequacy of the filter, now judged by reflection, was brought about by the intensive accelerated efforts to replace and preclude, wherever possible in the US atomic energy program, use of filters made of combustible materials. This desire for fire resistance of filters has proliferated widely among other members of the international atomic energy family. The intensive AEC effort caused US industry to produce filters of fire-resistant design but without the opportunity for development of manufacturing technology adequate for ensuring reliability of the filter. The state of the fire-resistant filter today is in sharp contrast to the 1959 filter. The testing program, coupled with a program for continuing improvement of the filter, has resulted in the effective removal of radioactive aerosols at atomic energy installations on a consistent and dependable basis. (auth)

**29064** ELECTROSTATIC SPRAY SEPARATOR. Joubert, J. D. (Faculte des Sciences, Lyon). pp 235-9 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968. (In French).

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The capture of micron and sub-micron particles in gases can be increased by using small collectors. However, this leads either to a considerably increased overall charge loss or to partial entrainment of the primary collectors. To overcome these two drawbacks, an electrostatic process was developed to give the primary collectors an electrical charge. When particles are captured, the effectiveness of the primary collector increases. On the basis of the results obtained it is possible to compare the instrument with traditional separators. (auth)

**29065** COLLECTION EFFICIENCY OF WATER DROPLETS FALLING THROUGH AN AEROSOL. A PRELIMINARY REPORT. Kerker, M.; Matijevic, E.; Viswanathan, N. S.; Cooke, D. D. (Clarkson Coll. of Tech., Potsdam, N. Y.). pp 533-40 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The collection efficiency of water droplets falling through a NaCl aerosol is approximately 7%. The modal radius of the aerosol particles ranges from 0.2 to 0.4 $\mu$m and the water droplets have radii from 0.06 to 0.11 cm. The droplets emerge from the scavenging tube of 81 or 98 cm at about 0.7 to 0.8 of the terminal velocity. The particle size of the aerosols was determined by light scattering; the analysis of the NaCl collected by the falling droplet was carried out by flame photometry; the weight of the aerosol was determined by direct weighing after collection in a thermal precipitator. (auth)

**29066** A SUBMICRON PARTICLE PRECIPITATOR BASED ON WATER VAPOR CONDENSATION. Melandri, C.; Prodi, V.; Rimondi, O.; Tarroni, G. (CNEN, Bologna). pp 541-50 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

An aerosol particle precipitator has been built composed basically of a gap where a strong water vapour concentration gradient and supersaturation are established. The main mechanism causing precipitation has proved to be particle nucleation and growth which greatly enhance the settling velocity under gravity. The effects of flow rate and particle concentration at the inlet were studied: the parameter ruling the deposition efficiency is the amount of water available to each particle. The contribution of thermophoretic, diffusiophoretic and gravitational forces is also evaluated. The tests were performed with DOP smoke (median diameter 0.3 $\mu$m) and with the aid of an aerosol photometer. The collection efficiency under specific operating conditions is better than 99.97%. (auth)

**29067** ENVIRONMENTAL PROPERTIES AND INSTALLATION REQUIREMENTS OF HEPA FILTERS. Burchsted, C. A. (Oak Ridge National Lab., Tenn.). pp 177-91 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The ability of HEPA (i.e., "absolute") filters to withstand severe environmental conditions is often critical to reliable operation of a contaminated exhaust system. The installation, mechanical strength, and the heat, moisture, and corrosion resistance of HEPA filters determined during the course of the filter development program are discussed. As a result of these findings, wood-cased filter units are recommended in preference to steel-cased filter units wherever possible; wood-cased filter units should have rabbeted casing joints, not butt joints. The limiting temperature for continuous exposure of HEPA filters to hot air is 400°F; above this temperature the tensile strength of the media drops sharply, to as little as 50% of the room-temperature tensile strength at 500°F. Fibre fracture and fibre loss occur at temperatures in excess of about 550°F. The limiting temperature of the assembled filter element is actually determined by the sealant used between the casing and the frame and, for wood-cased units, the casing material. Plywood is good for continuous exposure at temperatures up to 300°F for periods up to 48 hours, and up to 200°F for indefinite exposure (i.e., weeks or months). Steel is good for any temperature within the useful operating range of the media, although damage may be caused by differential expansion between the casing and the filter pack. Volatilization and reduction in shear strength of adhesives limits continuous operating temperatures to 250 to 350°F for periods up to 48 hours, and 200 to 275°F for indefinite exposure (according to adhesive used in manufacture). Steel-cased units with special sealants may withstand substantially higher continuous operating temperatures but in most cases are unable to meet the requirements of Underwriter's Laboratories Standard UL-586 for fire and hot (750°F) air. Resistance of the filter element to flexure, vibration damage, "working" of casing joints, gasket relaxation, and casing damage under abnormal pressure loadings is in large part a function of the mounting frame or fixture in which the filter is installed. Critical aspects of mounting frame and fixture design are structural rigidity, the method of joining individual frame members and the method of sealing the frame or fixture into the filter housing (all-weld construction and sealing preferred); the tolerances on dimensions, flatness, alignment, and surface finish of gasket seating surfaces,

rigidity of filter clamping devices, and uniformity and degree of compression of filter gaskets in the frame or fixture. Recommendations on each of these factors are presented. (auth)

**29068** RECLAMATION OF A PARTIALLY PLUGGED GLASS FIBRE VENTILATION FILTER AT THE HANFORD PUREX NUCLEAR FUELS REPROCESSING PLANT. Clark, B. E.; Davis, D. F.; Schmidt, W. C. (Atlantic Richfield Hanford Co., Richland, Wash.). pp 193-208 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

Canyon ventilation air from the Hanford Purex Nuclear Fuels Reprocessing plant is exhausted through a filter system before being released to the atmosphere. The filter installation consists of a bulk-particulate removing, glass fibre fore-filter, and a fine-particulate removing, high efficiency, glass fibre after-filter. The original filter installation was built in 1955 during plant construction and operated satisfactorily until early 1964 when the fore-filter indicated a loss of capacity because of particulate loading. Construction of a new filter installation was started immediately and it was put into operation in 1965. When plugging of the original filter became evident, a program was initiated to define the cause of the problem and to develop, if possible, a way to reclaim the filter without damaging it. Samples of filter entrance air indicated a large percentage of the particulate to be crystalline ammonium nitrate. Core samples of the fore-filter glass fibre bed showed a predominantly ammonium nitrate loading confined to the inlet side of the bed. In a laboratory unit, an ammonium nitrate loading was shown to displace and disperse in the glass fibre bed, with resulting reduced pressure drop for a given air flow, by passing highly humidified air through the glass fibre bed. Based on the laboratory studies the partially plugged original filter, which had been removed from operation, was treated for reclamation using a small flow of highly humidified air through the fore-filter. The results of the reclamation treatment were satisfactory and it was possible to return the original filter installation to service handling the entire exhaust ventilation flow. The filter was reclaimed at a cost of $15000; the filter replacement cost $75000. While the reclaimed filter again developed a high pressure drop after five months of service and is not now in service, it remains useful as an emergency back-up to the replacement filter. (auth)

**29069** THE APPLICATION OF PLASTIC FIBRE HEPA FILTERS TO THE TREATMENT OF AIRBORNE RADIOACTIVE WASTES. Becker, F. (Delbag Luftfilter GmbH, Berlin); Kratel, R. E. pp 209-14 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

HEPA filters used to separate airborne radioactive wastes must not be inflammable. This particular safety requirement is met almost ideally by HEPA filters made of glassfibre. Plastic-fibre filters are inflammable, and therefore they appear to be unsuitable for the purpose from a safety standpoint. While glass-fibre filters are rather bulky when disposed of, plastic-fibre filters can be reduced to tiny lumps by the use of suitable solvents. Filter frame and filter layer are moulded together using identical plastic material. The use of solvents and the application of subsequent evaporation techniques will reduce the bulk of the radioactive waste to a minimum. The plastic-fibre filter layer offers a method of recovering valuable radioactive components. Safety requirements, however, make it compulsory to combine plastic-fibre filters with glass-fibre filters of the HEPA-type. Several applications were demonstrated and the results discussed. (auth)

**29070** DESIGN AND OPERATION OF A LARGE SAND BED FOR AIR FILTRATION. Sykes, G. H.; Harper, J. A. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. pp 215-20 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

Large sand beds to filter exhaust air from radiochemical separation plants have performed satisfactorily for 13 years at the Savannah River Plant. The beds are 100 × 240 × 8 feet deep and are made from layers of sized sands and gravels. Activity penetrates only to the smallest-mesh (30 to 50) sand; about 1000 curies of gamma activity is estimated to be in the bed. Filtering efficiency has remained at 99%. Resistance to air flow has increased in the beds throughout the years of operation. Some increased pressure drop resulted from groundwater leaking into the sand. Air flows have generally been maintained in excess of 115,000 $ft^3$/min. Filter differential pressures currently are in the range of 8 to 10 inches of water. (auth)

**29071** HIGH TEMPERATURE PROPERTIES OF ACTIVATED CARBON. PART I. DESORPTION OF IODINE. PART II. STANDARD METHOD FOR IGNITION TEMPERATURE MEASUREMENT. Milham, R. C. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. pp 417-37 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The removal of iodine from activated carbon by flowing air was measured at elevated temperatures to evaluate both various carbons and the effects of variables, such as service, partial regeneration, and temperature, on desorption. The preliminary results are reported. A standard method was developed to measure ignition temperature, to evaluate promising new types of activated carbon, and to evaluate the effects of variables, such as air flow, bed properties, impregnants, and plant service, on ignition temperature. The standard method and results of the evaluation are reported. (auth)

**29072** THE EVALUATION OF THE IGNITION TEMPERATURE OF ACTIVATED CHARCOALS IN AIR, STEAM, OXYGEN, AND OXIDES OF NITROGEN. Kovach, J. L. (North American Carbon, Inc., Columbus, Ohio). pp 439-47 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The ignition temperature of impregnated and unimpregnated activated charcoals currently used for the adsorption of various forms of radioactive iodine is evaluated in detail. The standardized quartz ignition temperature apparatus was used for the experiments. Atmospheric conditions and gas-charcoal residence times existing in nuclear power reactor containment recirculating filter systems, emergency off-gas filter systems and fuel reprocessing plant filters were simulated for the ignition experiments. A theoretical explanation based on the experimental data is given for the contributing effects of charcoal properties, impregnants and the gas composition. The proper selection of activated charcoals for gaseous iodine filtration is discussed. (auth)

**29073** REMOVAL OF IODINE AND METHYL IODIDE BY A FULL-SIZED CHARCOAL FILTER. Murata, T.; Kamiya, K. (Hitachi Research Lab., Ibaraki, Japan). pp 451-63 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

This investigation, performed under conditions simulating those of a reactor accident, was undertaken to evaluate the efficiency of charcoal filters in removing iodine containing minute amounts of methyl iodide. The experiment was run in two series. In the first the efficiencies of small filters, diam. 8.0 cm and thickness from 0.5 to 9.0 cm, were determined under various flow conditions. It was found that the logarithms of the decontamination factors of both iodine and methyl iodide with the filter were approximately proportional to the thickness of the filter. Since the proportionality constant represents the filter efficiency under a given condition, the effects of operational conditions on this constant, such as temperature, humidity, concentration of iodine or methyl iodide, and air velocity passing through the filter, were investigated. From the results of these measurements, equations expressing the efficiency of the filter as a function of the constants were obtained. The applicability of the equations to large-scale filters was confirmed in the second series of experiments. A full-size filter unit (600 × 600 mm) consisting of prefilter, absolute filter and charcoal filter was constructed for the tests. Humid air containing iodine or a mixture of iodine and methyl iodide was passed through the filter unit, and the efficiency of each filter was determined. The efficiencies for iodine and for the mixture of iodine and methyl iodide agreed closely with those calculated with the equations. (auth)

**29074** EFFICIENCY OF VARIOUS FILTER PACKINGS FOR REMOVAL OF $^{131}I$ AND ITS COMPOUNDS. Hirling, J. (Inst. of Isotopes, Budapest). pp 465-83 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

In the course of production of $^{131}I$, a radioisotope produced on a relatively large scale in Hungary, the problem of waste disposal is considered as one of the most important. In spite of careful treatment of waste liquids, the radiation hazard due to volatile iodine compounds present as admixtures of long-lived tellurium activities still demands consideration. Other difficulties have arisen regarding the total capacity and efficiency of the filter system, and all of these problems are related to different valency states of iodine and its compounds. The evaluation of various filters and extensive investigations on the volatility and/or the physical-chemical behaviour of carrier-free radioiodine, as affected by pH, pretreatment and certain chemicals, are described. (auth)

**29075** SUPERCONDUCTING MAGNET SYSTEM FOR INTRAVASCULAR NAVIGATION. Montgomery, D. B. (Massachusetts Inst. of Tech., Cambridge); Weggel, R. J.; Leupold, M. J.; Yodh, S. B.; Wright, R. L. J. Appl. Phys., 40: 2129-32(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

A magnet system capable of guiding a ferromagnetic-tipped catheter through vessels in the body would greatly facilitate many medical treatments by providing access to parts of the body otherwise inaccessible except by major surgery. A rotatable iron magnet which has been employed in preliminary experiments with laboratory animals has indicated the feasibility of this technique, but a more advanced system is required for sophisticated medical applications. A proposed design is described for a superconducting magnet system, with a 10 in. room-temperature access, which can exert an arbitrarily directed force of 200 times that of gravity on a tip anywhere within the head. A larger but otherwise similar system could be used for catheterization of any part of the body. (auth)

**29076** MAGNETIC SUSPENSION AND GUIDANCE FOR HIGH SPEED ROCKETS BY SUPERCONDUCTING MAGNETS. Guderjahn, C. A. (Atomics International, Canoga Park, Calif.); Wipf, S. L.; Fink, H. J.; Boom, R. W.; MacKenzie, K. E.; Williams, D.; Downey, T. J. Appl. Phys., 40: 2133-40(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Guidance of high speed, 5000 m/sec rockets in evacuated tubes may be accomplished by eddy-current repulsion between moving superconducting coils (on the rocket) and stationary sheets of copper or aluminum. A method for determining lift and drag forces of moving rectangular coils over an infinite plane sheet is presented. The lift force saturates at high speeds v, the drag forces decrease as $v^{-\frac{1}{2}}$ at high speeds, while the power dissipated increases as $v^{\frac{1}{2}}$ at high speeds. Methods of determining lift and drag forces from scale models of finite systems are discussed. The forces as obtained from impedance measurements on scale models in circular conducting tubes are given. (auth)

**29077** RESULTS OF TESTS ON AN 8.8-TESLA, 51-CM-BORE MAGNET SYSTEM. Lucas, E. J. (Avco Everett Research Lab., Everett, Mass.); Stekly, Z. J. J.; DeWinter, T.; Laurence, J.; Coles, W. J. Appl. Phys., 40: 2101-6(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

As an interim step in a program to build an 8.8 tesla, 51-cm-bore coil system, tests were run on four of the six individual modules that comprise the system. These tests were run on two modules wound with a stabilized reinforced $Nb_3Sn$ strip and two modules wound with a stabilized NbTi conductor. All of the modules were instrumented with heaters to determine their stability characteristics. Data were taken on the $Nb_3Sn$ modules both at 4.2°K and sub $\lambda$ temperatures while the NbTi modules were run at 4.2°K only. The performance of each module is discussed and compared with the performance predicted from data previously taken on small test coils. (auth)

**29078** PADDLE WHEEL SAMPLER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1872).

3 drawings.

A waterwheel-type sampler is described that is suitable for use either in a plant stream or in a river. The samplers collect a 1 to 2 gallon sample per week at a rate proportional to stream flow. The sampler when used in the Savannah River worked most smoothly in water flows of ½ to 2 surface ft/sec. The weight of the waterwheel must be light, therefore, a lucite paddle wheel weighing 0.6 lb is used. In a plant stream a modified smaller version is employed. (For details see TID-4100 Suppl. 53)(see also 14: 8546). (F.S.)

**29079** BEARINGS FOR NUCLEAR ENGINEERING. Heath, H. H. (English Electric Co. Ltd., Whetstone, Eng.). Proc. Inst. Mech. Eng. (London), 182: 449-59(1967-68).

From Conference on Lubrication and Wear: Fundamentals and Application to Design, London, England. See CONF-670982.

Problems affecting the use of bearings and lubricants in nuclear reactors are discussed and the present state of research and development is reviewed. Some comments on design practice and procedures are included. (auth)

**29080** LUBRICATION AND WEAR: FUNDAMENTALS AND APPLICATION TO DESIGN. Proceedings of the Institution of Mechanical Engineers, London, 25th-29th September 1967. Proc. Inst. Mech. Eng. (London), 182: 1-643(1967-68). (CONF-670982).

Thirty-seven papers were presented at the conference. A separate abstract was prepared for one paper. The remaining 36 papers covered various topics relating to lubrication and wear of bearings, but not within scope of NSA. (F.S.)

*For an abstract of the individual paper see: 29079.*

## Heat Transfer and Fluid Flow

*Refer also to abstracts 29055, 29962, 31165, and 31168.*

**29081** (AERE-M-2159) STUDIES OF TWO-PHASE FLOW PATTERNS BY SIMULTANEOUS X-RAY AND FLASH PHOTOGRAPHY. Hewitt, G. F.; Roberts, D. N. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1969. 28p. Dep. CFSTI. UK 7s. 0d.

Studies are reported of the flow patterns in vertical upward flow of air-water mixtures in a 1¼ inch bore tube at pressures ranging from 6 to 65 psig. The flow pattern was observed by means of simultaneous high speed flash and high speed x-ray photography. Particular attention was paid to the region of high liquid rates where ordinary photographic methods are inadequate. The development of macroscopic structure within the flow leading to annular and wispy annular flow was clearly demonstrated. (auth)

**29082** (ANL-7491) CALCULATION OF STEADY PLANE AND AXISYMMETRIC SUPERSONIC GAS FLOWS CONTAINING AN ARBITRARILY LARGE NUMBER OF SHOCKS. Taylor, David B. (Argonne National Lab., Ill.). Oct. 1968. Contract W-31-109-eng-38. 176p. Dep. CFSTI.

A method is described that will yield a weak solution of the plane or axisymmetric supersonic-gas-flow equations. In regions of continuity, integration along characteristics is used to determine the solution on successive normals to the streamlines of the flow. Special techniques are presented to introduce and keep track of the arbitrarily large number of shocks, slip lines, and discontinuities of gradient which arise when the boundaries of the flow are specified with arbitrary piecewise continuity. The methods given may be adapted to determine weak solutions of other hyperbolic systems with two independent variables. (auth)

**29083** (RT/ING-(69)-1) DISCONTINUITY EQUATION FOR TWO-PHASE FLUIDS. Basso, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1969. 26p. (CONF-681101-31). Dep.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

The flow of heterogeneous fluids, such as vapor-liquid mixtures, is often characterized by the fact that the two phases move with unequal velocities (slip flow). This study shows that the vapor to liquid velocity ratio, i.e., the slip ratio, can be theoretically determined as function of thermodynamic balance and unbalance variables, considering the vapor-liquid interface as a fluid-dynamic discontinuity. (auth)

**29084** A NON-EQUILIBRIUM DESCRIPTION OF TWO-PHASE ANNULAR FLOW: APPLICATION TO THE BURNOUT PREDICTION. Biasi, L.; Clerici, G. C.; Sala, R.; Tozzi, A. (Univ., Milan). Int. J. Heat Mass Transfer, 12: 319-31(Mar. 1969).

A description is given of a heat-transfer annular dispersed flow in terms of non-equilibrium in the phase distribution. A simple equation relating film flowrate variation to heat flux and to the departure from equilibrium is used to predict the dry-out point in circular ducts. The results obtained are compared with the experimental burnout data for uniform and non-uniform heating. (auth)

**29085** SELF-CONTROLLING, $D_2O$-MODERATED AND BOILING-WATER COOLED REACTOR. Torikai, Kinichi (to Japan Atomic Energy Research Inst.). Japanese Patent 1969-2677. Feb. 4, 1969. Filed Nov. 25, 1966.

In the reactor proposed, a negative reactivity due to boiling of the $D_2O$ moderator is obtained with an increase in the reactor power output. The thermal efficiency of the reactor is improved, because the light water from the turbines can be heated by the moderator, before returning to the reactor core. In the $D_2O$ moderated, light-water cooled boiling reactor, coolant water enters the core at the core bottom and goes up through the fuel channels; from above the core, the steam produced flows to the turbines, and then through the condenser to the core bottom. The $D_2O$ moderator surrounds the fuel channels in the reactor core tank. Within the moderator fuel elements are installed to heat the $D_2O$ moderator. The water from the turbines or from the condenser is led through the heated moderator just inside the core tank. After heating it is returned to the reactor core through a preheater. (NSA of Japan)

**29086** GAZODINAMIKA I TEPLOOBMEN. SBORNIK I. (Gas Dynamics and Heat Exchange. Volume I). Ginzburg, I. P. (ed.). Uchenye Zapiski Leningradskogo Ordena Lenina Gosudarstvennogo Universiteta im. A. A. Zhdanova, No. 338. Seriya Matematicheskikh Nauk, Vypusk 43. (Scientific Papers of the Leningrad State University, No. 338. Mathematical Sciences Serie, Issue No. 43). Leningrad, Izdatel'stvo Leningradskogo Universiteta, 1968. 148p.

Seventeen articles are presented on the problems in gas dynamics and heat transfer in solids during super-speed motion. The first few articles discuss theoretical studies related to laminar gas flow. Turbulent flow and the effects of magnetic fields on gas and fluid flow in turbulent boundary and jet distribution in step cascade channels are discussed. The paddi-mechanism in supersonic flow, gas flow in flat ducts and separate flow in conical nozzles are also discussed. (R.V.J.)

**29087** METHOD OF INVESTIGATING THE MOTION OF GAS BUBBLES IN LIQUIDS BY MEANS OF A RADIOACTIVE BUBBLE. Campanile, A. (Societa Ricerche Impianti Nucleari, Saluggia, Italy); Galimi, G.; Goffi, M.; Magrini, U.; Pisoni, C. Energ. Nucl. (Milan), 16: 386-91(June 1969).

A method is described to measure the steady state velocity of gas bubbles in a liquid, based on the activation of a single bubble. This method permits the evaluation of the gas phase velocity by the direct measurement of the activated bubble ascent velocity. (auth)

**29088** FORCED CONVECTIVE BOILING HEAT TRANSFER TO DIPHENYL IN CONCENTRIC ANNULI. Michiyoshi, Itaru; Nakajima, Tsuyoshi; Inoue, Masashi; Ito, Yutaka (Kyoto Univ.). Nippon Genshiryoku Gakkaishi, 11: 272-8(May 1969). (In Japanese).

Forced convective boiling heat transfer to diphenyl flowing upwards under atmospheric pressure through two vertical concentric annuli 1 m long and of effective diameters measuring either 11.4 or 18.0 mm is discussed. The inlet temperature of diphenyl was 215 ~ 245°C, the Reynolds number $1.9 \times 10^4 \sim 5.7 \times 10^4$, and the heat flux was less than $4.2 \times 10^5$ kcal/m$^2$·hr. Measurements were made of the turbulent heat transfer in the non-boiling region, the heat flux at incipient boiling, the hysteresis of boiling heat transfer, the relationship between boiling heat transfer and the flow pattern of two-phase flow, and the effects of fouling, and the burnout heat flux. Correlations of experimental data and some discussions are presented on these items. (auth)

## Isotope Technology

*Refer also to abstracts 28995, 29047, 29048, 29251, 29621, 29679, 30106, 30857, and 30915.*

**29089** (AD-678727) GAMMA EXPOSURE RATES FROM A VARIETY OF AMBIENT OR NONAMBIENT CYLINDRICAL FISSION-PRODUCT SOURCES: A MODEL FOR THEIR CALCULATION. Young, Frank H. (Naval Radiological Defense Lab., San Francisco, Calif.). June 7, 1968. 40p. (USNRDL-TR-68-88). CFSTI.

A mathematical model is developed for the calculation of free-field gamma exposure rates from a variety of $^{235}$U-mixed-fission-product sources. The source geometries considered include ambient or non-ambient cylindrical or annular sources, and an ambient cylindrical source encased in a non-ambient topped annulus. In the integration procedures the self-attenuation of the sources is considered and time-dependent effective attenuation coefficients are employed to characterize the attenuation and absorption of the spectra of gamma photons emitted from the fission product radionuclides. The model is formulated in a manner suitable for numerical evaluation. (auth) (USGRDR)

**29090** (BNWL-1041) FABRICATION OF PROMETHIUM SESQUIOXIDE HEAT SOURCES BY HIGH ENERGY RATE FORMING. Davis, N. C.; Brite, D. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1969. Contract AT(45-1)-1830. 44p. Dep. CFSTI.

High Energy Rate Forming (HERF) was used as a fabrication method for the densification of encapsulated promethium sesquioxide. The development and characteristics of the HERF process are presented. Simulated radioisotope materials were used to develop capability for controlled dimensional integrity, and promethium sesquioxide has been densified in various metal claddings for compatibility testing. (auth)

**29091** (DP-1196-1) SAVANNAH RIVER LABORATORY ISOTOPIC POWER AND HEAT SOURCES. PART I. $^{60}$Co. Quarterly Progress Report, January–March 1969. Hilborn, H. S. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr. 1969. Contract AT(07-2)-1. 25p. Dep. CFSTI.

Fabrication procedures are being developed to provide high density wafers of CoO, (Co,Mg)O, and $CoAl_2O_4$ for irradiation tests and evaluation as high melting, oxidation resistant heat source fuels. Haynes 25 will be the preferred capsule alloy for most uses of $^{60}$Co at temperatures to 1000°C. Inactive capsules of Haynes 25 increased uniformly in diameter by 0.006 and 0.008 inch in 10,000 hour tests at 1000°C. This increase is consistent with the density change associated with the cobalt phase transformation above 417°C. A preliminary scope of work was completed for a new facility for $^{60}$Co capsule testing. Initial tests were run to measure the compatibility of molten cobalt with tungsten. Selection of techniques and equipment for welding refractory alloy capsules for SRL tests was begun. (auth)

**29092** (K-OA-1559) METHOD FOR CALCULATING CASCADE GRADIENTS FOR MULTICOMPONENT SYSTEMS INVOLVING LARGE SEPARATION FACTORS. Blumkin, Samuel (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 15, 1968. Contract W-7405-eng-26. 14p. Dep. CFSTI.

A mathematical model, involving no limitation as to the magnitude of the separation factor, was derived for the separation of the components of a multicomponent mixture. The model is written for separation by means of permeselective membranes. It is also applicable with little modification to other separative processes involving discrete stages. The method by which the equations are solved to obtain the concentration gradients in a specified cascade is detailed. A Fortran IV code was written to perform the stage calculations for a four-component system with either the stage upflow or the membrane area specified. With minor modifications the program can be extended to a larger number of components. (F.S.)

**29093** (MLM-1637) APOLLO LUNAR RADIOISOTOPIC HEATER SUMMARY REPORT. Kelly, D. P.; Avona, V. L. (Mound Lab., Miamisburg, Ohio). Apr. 30, 1969. Contract AT-33-1-GEN-53. 20p. Dep. CFSTI.

Three Apollo Lunar Radioisotopic Heaters were designed and fabricated for environmental protection of seismic instrumentation on the moon. The heater will be part of the Early Apollo Scientific Experiments Package for the first lunar landing. Each heater was fueled with 37.6 g of plutonium-238 dioxide microspheres to produce 15 thermal watts. The fuel was encapsulated in multiple containers of Ta-10 wt % W alloy, Pt-10 wt % Rh alloy, titanium, graphite, and stainless steel to ensure safety. The safety of the design was confirmed by a series of tests which simulated all possible accidental conditions surrounding the Saturn V launch and flight. The three sources were shipped to Kennedy Space Center. (auth)

**29094** (N-69-10680) SIMULATED RADIOISOTOPE THRUST SYSTEM AND COMPONENT DEVELOPMENT. Final Report. Viventi, R. E.; Neiman, W. N.; Zimmerman, W. F. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). [1968]. Contract NAS5-9670. 254p. (NASA-CR-97586; GESP-87). CFSTI.

A single-jet thruster designated TSK 2000-1P was designed, fabricated, performance tested and preflight qualified. A more complex thruster, consisting of four attitude-control thrusters and one station keeping thruster grouped around a common heater was also designed, fabricated, and tested. Two versions of a radioisotope-heated thruster were fabricated—one with a radioisotope heat source and the other with an electrical simulator. A higher temperature (3000°F) simulated radioisojet thruster was designed after preliminary heater tests had been performed satisfactorily. An ammonia decomposition catalyst study was performed with decomposition demonstrated at temperatures as low as 1500°R. One of the TSK 2000-1P thruster bodies was modified to include a catalyst bed and a significant increase in delivered specific im-

pulse was seen. A major effort was made to develop a long-life heater to operate at 2000°F for 10,000 hours. A 6600-hour life and a cycle life of over 120 cycles from room temperature to 2000°F were demonstrated. (auth) (STAR)

**29095** (SC-RR-69-125) APOLLO LUNAR RADIOISOTOPIC HEATER AEROTHERMODYNAMIC SUMMARY REPORT. (Sandia Labs., Albuquerque, N. Mex.). Mar. 1969. 56p. Dep. CFSTI.

Results of the aerodynamic, trajectory, ablation, thermal, and stress analyses completed on the Apollo Lunar Radioisotopic Heater (ALRH) between December 1968 and February 1969 are summarized. Results of the experimental program conducted during the same time period in the Sandia High Enthalpy Arc Tunnel and the NASA/MSC 1.5 megawatt facilities are included. (auth)

**29096** (WANL-3857-1) STUDY ON AN IMPLANTABLE POWER SOURCE FOR CIRCULATORY SUPPORT DEVICES. Vol. 1, Vol. 2, and Appendices. Final Report. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Dec. 1968. Contract AT(30-1)-3857. 462p. (WANL-TME-1749). Dep. CFSTI.

The development of an implantable power source for a human circulatory support device is described. The development of the power source conceptual design definition was the major task. Subsidiary efforts were the definition of requirements and constraints, parametric analysis of the concept and system optimization, identification of concept design and developmental problems, comparative analysis between selected power source concept and other possible power source concepts, and program planning for future development. The power source consists of five major subsystems: a radioisotope heat source, a Rankine cycle rotary piston steam engine which converts the decay heat of the isotope to shaft power, a pump which converts the rotating shaft power to hydraulic power, a heat exchanger which rejects unused heat to the blood stream, and a control system. Design concepts for each of the subsystems are presented. It was concluded that the implantable power source has the ultimate potential of development of a device that will provide the average user with sufficient circulatory power for complete rehabilitation in a blood power sense. (R.C.K.)

**29097** THE PRACTICALITY OF USING ATOMIC RADIATION FOR WASTEWATER TREATMENT. Ballantine, D. S.; Miller, L. A.; Bishop, D. F.; Rohrman, F. A. J. Water Pollut. Contr. Fed., 41: 445-58(Mar. 1969).

Four principal applications of ionizing radiation to water pollution control are considered: sludge beneficiation (improved sludge handling and water removal), total destruction of organics, disinfection (bacterial reduction), and selective removal of refractories or specific compounds. These applications were evaluated for efficiency of utilization of the radiation energy and the cost of the proposed treatment process. The sources of radiation discussed were $^{60}Co$, $^{137}Cs$, accelerators, reactor loops, fuel elements, and mixed fission products. Treatment costs, developed on an assumed radiation dose requirement, ranged from $0.13 to $1.58/1000 gal of irradiated wastewater for reactor loops and spect fuel elements, respectively. This reactor loop cost is speculative because of the limited experience and uncertainties in reactor loop systems. The most credible costs are $1.04/1000 gal based on $0.40/Ci $^{60}Co$ and $0.69/1000 gal for accelerators. The accelerator cost is questionable because the proposed 10-MeV machines have not been tested in routine operations. The most promising area appears to be sludge beneficiation since the volume irradiated is a factor of 100 less than full plant flow. If significant improvements in sludge handling and dewatering could be achieved at the 0.1 Mrad dose level, the incremental cost per 1000 gal of flow would be only $0.0013 for the reactor loop. Successful radiation applications in the other 3 areas may depend on the achievement of chain reactions (G values at least in excess of 100) or on significant synergistic effects of radiation with other components. It was concluded that more experimental data are required to permit accurate cost calculations and that alternative treatment techniques are presently more competitive. (BBB)

**29098** WEAR STUDIES OF LEAD BRONZE SLIDING BEARINGS USING ACTIVATED SILVER PINS AS THE RADIOACTIVE INSERTIONS. Leonhardt, J.; Hilbig, H.; Bonin, H. (Institut fuer Angewandte Radioaktivitaet, Leipzig. VEB Kuehlautomat, Berlin). Isotopenpraxis, 5: 62-3(Feb. 1969). (In German).

Wear studies were carried out with lead bronze sliding bearings using activated silver pins as the radioactive tracer and by discontinuous sampling from the lubricant. This technique enables the wear rate and the wear amount to be determined in the running-in process of such bearings in a compressor aggregate for different loads having little loss of material. (auth)

**29099** A SIMPLE METHOD OF LABELLING GRAVEL (PYRITES) WITH RADIOACTIVE ISOTOPES. Runge, K. (Institut fuer Anwendung Radioaktiver Isotope, Dresden). Isotopenpraxis, 5: 60-1(Feb. 1969). (In German).

$^{192}Ir$ is fixed on the surface of the gravel grains by formation of protective layers consisting of silicone lacquer and molten glass on them. The properties of such layers were investigated with respect to the fixation of the radioactive nuclide on the pyrite surface. (auth)

**29100** SEALED SOURCES. Vormum, G. (Institut fuer Angewandte Isotopenforschung, Berlin). Isotopenpraxis, 5: 46-53(Feb. 1969). (In German).

The production of radioactive sealed sources in G.D.R. is described. A survey of the present production program follows the description of some important stages of the development in this field during a period of more than ten years. Problems of quality testing and activity measurement are also discussed. Some points of future development, which are already discernible are finally considered. (auth)

**29101** METHOD OF CORE ANALYSIS USING THERMAL NEUTRON CAPTURE CROSS SECTION. Youmans, Arthur H. (to Dresser Industries Inc.). U. S. Patent 3,426,203. Feb. 4, 1969. Filed Jan. 4, 1965.

Apparatus and methods are described for investigating the character of subsurface earth formations such as analyzing cores and drill cuttings taken from earth boreholes. The macroscopic thermal neutron capture cross section is determined in situ using a pulsed fast neutron source and a gamma radiation detector. The rate of decline of the thermal neutron population in the earth formation is determined. Using the macroscopic cross section and the rate of decline, a quantitative measurement of the fluid saturation of the earth formation is found. (F.S.)

**29102** SELECTION OF THE SOURCE OF RADIATION FOR RADIOISOTOPE THICKNESS GAGE MEASUREMENTS. Drabkin, L. A. Zavod. Lab., 35: 304-6(1969). (In Russian).

Sources of beta radiation such as $^{204}Tl$ and $^{90}Sr-^{90}Y$, sources of combined radiation such as mixtures of the isotopes $^{144}Ce-^{144}Pr$ and $^{147}Pm$, sources of bremsstrahlung radiation such as $^{90}Sr-^{90}Y$ with a lead target 0.25 mm thick, and sources of gamma radiation such as $^{170}Tm$, $^{75}Se$, $^{137}Cs$, and $^{65}Zn$ were studied. The optimum thicknesses were determined from diagrams of the relative sensitivity in relation to thickness, which were obtained from radiation attenuation curves and were recorded for each source. (tr-auth)

**29103** FUEL CELL. Iijima, Hiroshi (to Japan Steel and Tube Corp.). Japanese Patent 1969-1849. Jan. 27, 1969. Filed July 18, 1962.

A fuel cell is described that employs radiation from a radioisotope and has many advantages resulting from the enhanced cell reactions at the electrodes caused by the radiation. The electromotive force of the fuel cells is not only increased, but the current density is raised and the efficiency is improved. In the fuel cell, consisting of a cathode and an anode, an oxygen chamber, a fuel-gas chamber, and a central electrolyte chamber, the walls of the oxygen and the fuel-gas chamber are coated with a paint containing a radioisotope. The radiation from the radioisotope irradiates the electrodes at the position of contact catalytic reactions. Any radioisotope may be used. (NSA of Japan)

**29104** DART RADIOISOTOPE THRUSTER. Isotop. Radiat. Technol., 6: 400(Summer 1969).

A radioisotope thruster applicable for reaction-control systems on future military spacecraft was successfully tested. The test was a key milestone in the Decomposed Ammonia Radioisotope Thruster (DART) exploratory development program. The basic DART configuration includes an encapsulated radioisotope heat source ($^{238}PuO_2$), one of four nozzles with a separate flow tube for each nozzle, passive thermal control, and a reentry module. Energy from the decay of the radioisotope heats and completely decomposes the ammonia propellant before expansion through a nozzle. Ammonia has a theoretical optimum specific impulse of 305 sec at 2000°F. DART is designed to operate in either the pulsed or continuous mode and can produce more than 100 millipounds of thrust. The DART heat source is also attractive for high-temperature radioisotope space power systems. (R.C.K.)

**29105** THE ENRICHMENT OF RADIOACTIVE $^{85}Kr$. Rathkamp, W. R. (Oak Ridge National Lab., Tenn.). Isotop. Radiat. Technol., 6: 347-52(Summer 1969).

The Oak Ridge National Laboratory thermal diffusion pilot plant for enriching radioactive $^{85}Kr$ is described. The $^{85}Kr$ pilot plant has produced to date 1460 curies of 15% $^{85}Kr$ by single-

pass operation and 370 curies of material containing 27.6% $^{85}Kr$ by a second-pass enrichment of partially concentrated material obtained as a by product of the 15% enrichment runs. This enrichment plant will continue to operate in the future producing 15% and eventually the full 40% design concentration of $^{85}Kr$. (D.H.M.)

**29106** INTENSIFICATION OF THE FLOTATION BY A PRIOR RADIOACTIVE IRRADIATION TREATMENT OF THE WATER. Klassen, V. I.; Malysheva, N. G.; Starchik, L. P. Tsvetn. Metal., No. 3, 8-9(Mar. 1969). (In Russian).

The irradiation tests were carried out with a 500 $\mu$Ci $^{90}Sr$ + $^{90}Y$ $\beta$ source and an about 3 Ci $^{144}Ce$ + $^{144}Pr$, $\beta$, $\gamma$ source, exposing the water used for flotation for periods ranging from 10 minutes to 48 hours. Minerals such as gunerite, spodumene, beryl, molybdenite, and chalcopyrite were also irradiated. It was found that use of irradiated water for the flotation helped to increase the leaching of spodumene by 8%. High leaching rates may be achieved under such conditions for certain minerals while keeping the reagent consumption low; however, in some cases, as for gunerite or beryl, the opposite is true. Irradiation of water causes radiolysis, resulting in the formation of free radicals $H^+$ and $OH^-$ which recombine to form $H_2$ and $H_2O_2$, changing also the pH of the medium by 0.1 to 1.2 units. Thus, irradiation of water prior to flotation may in some cases enhance the flotation process, increase the amount of mineral collected in the foam, decrease the consumption of expensive reagents and improve the selectivity of the process. (TTT)

## Materials Testing

*Refer also to abstracts 28737, 29061, 29063, 29957, 29958, and 30093.*

**29107** (KURRI-TR-43) PROCEEDINGS OF "THE 3RD STUDY MEETING ON NON-DESTRUCTIVE INSPECTION." (Kyoto Univ. (Japan). Research Reactor Inst.). Aug. 1967. 33p. (In Japanese). Dep.

Four papers presented at the Third Study Meeting on Nondestructive Testing are discussed. Topics covered include nondestructive inspection of reactor fuel elements by x-ray penetration, ultrasonics, and electromagnetic induction. Equipment, facilities, and methods are described for x-ray fluorescence penetration and x ray photography; ultrasonic inspection for internal defects and crystal grain sizes of metallic U; and electromagnetic induction inspection of fuel element cladding and fuel quality. (F.S.)

**29108** (N-69-22555) NONDESTRUCTIVE DETERMINATION OF $^{235}U$ DISTRIBUTION BY FIXED POSITION GAMMA SCANNING. Richardson, Paul J.; Berner, Dale C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr. 1969. 8p. (NASA-TM-X-1779). CFSTI.

A nondestructive method for determining fuel density variation in small, unirradiated, clad $UO_2$ plates is described. A plate is scanned at fixed positions instead of scanning a plate moving past a detecting system. Variations are calculated by a statistical sampling where it is not possible to analyze the whole plate. (auth) (STAR)

**29109** THE DETERMINATION OF CREEP CONSTANTS FROM STRESS RELAXATION TESTS WITH INHOMOGENEOUS STRESSES. Lewthwaite, G. W.; Mosedale, D. (Dounreay Experimental Reactor Establishment, Caithness, Scotland). J. Nucl. Mater., 31: 226-7(June 1969).

The behavior of beams and torsion specimens when used in stress-relaxation experiments has been analyzed for ideal solids using creep laws. It was shown how the experimentally observable deformations could be forecast if the creep law is known. A procedure is described by which the creep law may be obtained from the experimentally observed deflections. The analysis of results obtained from bent rectangular beams is given, but can be easily rephrased to deal with other geometries. The equation for the observable stress change at the surface of the beam is given. (J.C.W.)

**29110** OPTIMISING NEUTRON SCINTILLATORS FOR NEUTRON RADIOGRAPHY. Spowart, A. R. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Non-Destruct. Test., 11: 2-11(Mar. 1969).

Glass and granular neutron scintillators of various types and thicknesses were examined for their use in neutron imaging in neutron radiography, and the optimum forms of these scintillators were derived. The properties of the materials are optimised for both thermal and epithermal neutron detection and the relevance of the work to practical non-destructive testing problems is described. (auth) (UK)

**29111** REVIEW OF INSPECTION AND TESTING OF INSTALLED HIGH-EFFICIENCY PARTICULATE AIR FILTERS AT ORNL. Parrish, E. C.; Schneider, R. W. (Oak Ridge National Lab., Tenn.). pp 243-64 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

High-efficiency filters are indispensable elements in the contamination control programs of most atomic energy installations. These filters, if in good condition, will remove 0.3-$\mu$m particles from an air stream with an efficiency of 99.97% minimum. In the United States, it is standard procedure to measure the efficiency of new filters by determining the efficiency with which they remove a 0.3-$\mu$m particle diameter monodisperse aerosol of DOP from an air stream. This test is used by filter manufacturers and other quality assurance laboratories. The use of pretested high-efficiency filters does not ensure that the system in which they are installed will have a comparable efficiency. Experience has demonstrated that systems should be assumed to be inefficient until an in-place test shows the contrary to be true. Routine in-place testing of high-efficiency filter systems was initiated at ORNL in mid-1962. The in-place test method adopted by the Laboratory is patterned after the standard test used to measure the efficiency of new filter units. The principal difference is that the DOP aerosol used for the in-place test is polydisperse with an average particle diameter slightly larger than 0.3 $\mu$m. Though the basic in-place test has remained unchanged, six years of experience has resulted in refinement and standardization of techniques which permit wider application of the in-place test and more economical testing. To facilitate the in-place testing of all ORNL high-efficiency filter systems, a computer program was instituted in mid-1965. This program provides automatic advance notification to cognizant management and operating personnel when systems are scheduled for test. Similarly, test results are reported automatically. The computer program, present practice at ORNL with regard to in-place testing policy, techniques, and equipment, and the effect that six years of in-place testing has had on the overall problem of contamination control are discussed. (auth)

**29112** EFFICIENCY TESTING OF THE AIR CLEANING SYSTEM FOR A HIGH TEMPERATURE REACTOR. DeField, J. D.; Ettinger, H. J. (Los Alamos Scientific Lab., N. Mex.). pp 265-78 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The Los Alamos Ultra High Temperature Reactor Experiment (UHTREX) utilizes a helium-cooled, graphite-moderated reactor, employing refractory fuel elements. Under accident conditions, the effluent that may be released from this reactor requires an air-cleaning system capable of reducing radioactive gas and particulate contaminants to safe levels. Dioctyl phthalate and iodine-131 were used as test aerosols for the HEPA and activated carbon filters, respectively. Methods of aerosol generation and test procedures are detailed for the preinstallation tests of the carbon and in-place testing of the carbon and HEPA filters. The importance of visual inspection of the HEPA filters prior to installation and supervision of filter installation is discussed. In-place tests indicated desirable design changes which would simplify in-place testing procedures, expedite installation and future changing of the filters, and ensure operation of a more efficient system. Problems encountered during in-place testing, recommendations for the design of similar systems, and acceptance criteria used at LASL are discussed. (auth)

**29113** TESTING HEPA FILTERS FOR USE IN A HIGH NOISE LEVEL ENVIRONMENT. DeField, J. D. (Los Alamos Scientific Lab., N. Mex.). pp 291-9 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

During the pulsed cooling phase of nuclear reactor rocket engine testing as part of the Rover Program at Los Alamos Scientific Laboratory, the possibility of atmospheric release of radioactive particulates exists. To control this potential release, a special air cleaning system employing High Efficiency Particulate Aerosol (HEPA) filters was designed, constructed, and tested. A primary concern was the structural integrity of these filters under the intense noise levels that exist during reactor tests. Commercially available HEPA filters were subjected to noise levels simulating the acoustic environment that exists near a reactor during testing.

These acoustic exposures included both reverberant and progressive fields of varying time intervals and reached maximum sound pressure levels of 148 db. Filter efficiency tests using air-generated dioctyl phthalate (DOP) were performed before and after acoustic exposures and are reported. Details of the acoustic and DOP test methods are also discussed. (auth)

**29114** TESTING IODINE FILTERS FOR NUCLEAR INSTALLATIONS. Wilhelm, J. G. (Karlsruhe Nuclear Research Center, Ger.). pp 403-16 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The removal efficiency of iodine filters for nuclear installations was tested. The test method in use includes laboratory tests of the adsorber material (under MCA conditions for temperature, relative humidity, pressure, loading, stay time and bed depth) and in-place tests at the site of the installation. For removal of methyl iodide under high relative humidity KI-impregnated charcoal is widely used. Most of the data for charcoal removal efficiency available today result from experiments with tracer amounts of $CH_3{}^{131}I$ mixed with $CH_3{}^{127}I$. Considering MCA conditions, the validity of those data should be confirmed for specific activities on charcoal $10^3$ to $10^6$ times higher. Experimental data are given for realistic loadings with $CH_3{}^{131}I$ up to 1.0 Ci/g charcoal under 100% relative humidity. For standard laboratory adsorber tests a method is discussed for humidification and control of gas streams up to 100% relative humidity at elevated temperatures. The apparatus used is described. Experimental data are given for the removal efficiency and the adsorption of water in charcoal samples from long-time tests under 100% relative humidity. The overall test period was up to 98 hr simulating the phase of elevated pressure and, therefore, high iodine release from the reactor containment. The reproducibility of long-time tests under extremely high relative humidity is shown and discussed. A description of the hardware for in-place tests is included and results are given. (auth)

**29115** DETECTING ACOUSTIC EMISSION IN THE PRESENCE OF HYDRAULIC NOISE. Hutton, P. H. (Battelle-Northwest, Richland, Wash.). Non-Destruct. Test., 2: 111-15(May 1969).

The acoustic emission produced as metals deform and fracture can be used to monitor the integrity of nuclear reactor pressure boundaries, provided the emission data can be separated from background noise. Tests have shown that a sensing system using shear-wave sensors in the frequency range 1.5 to 2.5 MHz can detect acoustic emission in the presence of turbulent flow and cavitation noise, and at distances of at least 3 ft from the signal source. Further work is needed to improve the sensing technique, establish the maximum distance at which an emission signal can be reliably detected, and adapt the technique for practical use. (auth)

## Protective Structures

**29116** (AD-681231) APPLICATION OF MODIFIED ENGINEERING METHOD TECHNIQUES TO SKYSHINE RADIATION MEASUREMENTS. Final Report. Jenkins, Alvin L.; Hinkley, David E. (General Physics Corp., Ellicott City, Md.). Nov. 1968. Contract DAAA15-67-C-0589. 56p. (NDL-TR-117). CFSTI.

The results of US Army Nuclear Defense Laboratory (USANDL) skyshine reduction factor measurements for open and concrete-covered basements are compared with theoretical reduction factor formulations. New empirical procedures are developed within the engineering method format to improve the agreement between theory and experiment. In the covered basement cases, a new geometry factor is developed which includes the effects of scattered and unscattered radiation in the basement cover. In addition to the modified engineering method techniques developed for calculating skyshine reduction factors, a new method of calculating far field corrections is developed for experiments measuring skyshine exposure rates in open and covered basements. While the new method does not give corrections which differ significantly from other methods, it permits an estimate of the standard error in the far field correction and is less sensitive to the exposure rate measured for the outermost experimental annulus used in the USANDL experiments. (auth) (USGRDR)

## Radioactive Material Handling

*Refer also to abstracts 29014, 29020, 29021, 29058, 29059, 29062, 29063, 29065, 29069–29074, 29112, 29114, and 29982.*

**29117** (K-P-3505(Rev.1)) CYLINDER DECONTAMINATION, 2.5-TON STANDARD OPERATING PROCEDURE FOR OAK RIDGE GASEOUS DIFFUSION PLANT. Koteski, R. A. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Apr. 17, 1968. Contract W-7405-eng-26. 5p. Dep. CFSTI.

A method is described to clean and decontaminate a 2.5 ton cylinder used in shipping uranium hexafluoride. The procedures are given for the removal of material remaining after the emptying of the cylinder. Safety measures are outlined. (J.C.W.)

**29118** (STI/PUB-195) TREATMENT OF AIRBORNE RADIOACTIVE WASTES. Proceedings Series. Proceedings of a Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York, 26–30 August 1968. (International Atomic Energy Agency, Vienna (Austria)). 1968. 831p. (In several languages). (CONF-680811). IAEA $19.00; Austrian Schillings 491,-; £ 7.18.4; F.Fr. 93,10; DM 76,-.

A separate abstract was prepared for each of the 53 papers presented at the conference on the management and treatment of airborne radioactive wastes. (F.S.)

*For abstracts of individual papers see: 29014–29022, 29058–29074, 29111–29114, 29123–29143, 29284, and 29285.*

**29119** PIPETTING OF RADIOACTIVE OR AGGRESSIVE SOLUTIONS. Gebhardt, G. (Albert Funk Forschungsinstitut fuer NE-Metalle, Freiberg). Isotopenpraxis, 5: 78-9(Feb. 1969). (In German).

A normal pipette, which has a rubber ring on the upper end into which a vacuum tube or a suitable rubber tube can be placed, is used. A rubber ball is used to draw the liquid up into the pipette. (M.C.G.)

**29120** TONGS FOR HANDLING A NUCLEAR FUEL ROD. Hagiya, Miyoshi (to Hitachi Ltd.). Japanese Patent 1969-1784. Jan. 23, 1969. Filed Apr. 13, 1965.

Tongs for handling a fuel rod in a swimming-pool-type reactor are described. The tongs are made of a handle and flexible pipe connecting the tongs and handle. Where the bending stress is most applied, i.e., at the joint of the pipe to the part of the handle, a suitable means is employed to prevent failure at this point. Approaching the joint from the direction of the flexible pipe made up of wire windings, the pipe is wound with additional layers of wire, the number of windings increasing toward the joint. By this means, the situation is such that where the flexible pipe is most likely to bend during the tongs operation, the layers are greater in number, therefore, that part is prevented from its bending and thus protected from failure. (NSA of Japan)

**29121** SHIPMENT OF IRRADIATED FUEL FROM THE GARIGLIANO BWR TO WINDSCALE. Kavanagh, M. T. (United Kingdom Atomic Energy Authority, Windscale, Eng.); Ascione, G.; D'Anna, C. Energ. Nucl. (Milan), 16: 392-6(June 1969). (In Italian).

The methods and arrangements adopted for the shipment of the first batch of irradiated fuel discharged from the 160 MW(e) boiling water reactor of the ENEL Garigliano Power Station and dispatched to the UKAEA reprocessing plant at Windscale (England) are described. This was the first shipment of its kind on international scale. (auth)

**29122** ARE THE REGULATIONS OUT TO GET ME? Brobst, William A. (Dept. of Transportation, Washington, D. C.). Isotop. Radiat. Technol., 6: 425-8(Summer 1969).

New regulations by the Department of Transportation for the transportation of radioactive materials and interpretations which have come out of the development of these regulations are reviewed. Also discussed are special permits and their issuance, future changes, incorporation of IAEA criteria throughout the regulations, acceptable closure devices, enforcement of regulations, etc. (auth)

**29123** THE EFFECTS OF MOISTURE ON THE CHARACTER AND FILTRATION OF $UO_2$-STAINLESS STEEL AEROSOLS. Davis, R. J.; Truitt, J.; Gill, J. S.; Yuille, W. D. (Oak Ridge National Lab., Tenn.). pp 345-64 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The hazards associated with aerosols which might result from a serious accident in the operation of a water-cooled, nuclear reactor were studied. The filtration studies demonstrated efficiencies of filtration of practical aerosol materials with commercially available absolute fibrous filters. The experiment was conducted as follows: the aerosol was generated by recirculating air over an electric arc in which the consumed electrode was an irra-

diated stainless steel tube with a cylindrical $UO_2$ insert. The aerosol was recirculated through filter packs which contain three filters in series. The method was shown to be reproducible to one part in $10^4$. Efficiencies were measured for several commercial media as a function of velocity with dry and humid aerosol. Efficiencies are decreased above velocities of 7.5 ft/min. Non-waterproofed papers filter humid aerosol less efficiently than dry aerosol. The efficiency of waterproofed papers is also decreased by the humidity of the aerosol, particularly at high velocities and for particular media. A deleterious effect on filtration efficiency results when the media are stored for extended periods in a damp atmosphere. The filter penetrations were increased by as much as a factor of 20 as a result of storage in 100% humidity for six weeks. It was suggested, and theoretically justified, that this effect results from condensation of water between tiny fibers and the subsequent clumping of fibers due to the force of surface tension. The reaction between moisture and stainless steel-$UO_2$ aerosol particles generated in an electric spark was performed using electron microscopy. Moisture affects the shape of the agglomerates. In dry air the agglomerates are chains of primary particles, in moist air the agglomerates are clumps. A calculation of the rate of removal of particles from a containment by the two phenomena: thermophoresis and diffusiophoresis is presented. Under conditions of interest the time for removal of half the particles by these mechanisms was estimated to be $10^2$ to $10^5$ seconds. Experiments were done to demonstrate that spark generated $UO_2$-stainless steel particles grow substantially in condensing steam due to condensation of water and that the rate of settling is thereby enhanced. In the experiment, aerosol was mixed with steam and the mixture led into the bottom of an air-cooled condensor. Control experiments were run without steam. The number concentration, the mass concentration and the particle size distribution of the effluent aerosol were measured. The results show that the mass and number concentrations of the effluent aerosol are substantially reduced and the relative number of the larger particles is substantially increased by condensing steam. Theoretical extrapolation of the data to estimate the enhancement by condensing steam of the rate of settling of particles in a containment vessel was made. (auth)

**29124** CONCENTRATION AND COLLECTION OF KRYPTON AND XENON BY SELECTIVE ABSORPTION IN FLUOROCARBON SOLVENTS. Merriman, J. R.; Pashley, J. H.; Habiger, K. E.; Stephenson, M. J.; Anderson, L. W. (Oak Ridge Gaseous Diffusion Plant, Tenn.). pp 303-13 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

One of the most direct methods for removing krypton and xenon is selective absorption of the gases from a compressed, contaminated air stream using a chilled fluorocarbon solvent, such as refrigerant-12 (dichlorodifluoromethane). A development program is under way at the Oak Ridge Gaseous Diffusion Plant to provide the engineering scale-up data required for design of a krypton-xenon recovery plant using the absorption technique. The ORGDP work involves pilot-plant testing to collect performance data, as well as conceptual design and optimization studies. The goal of this program is to provide designers of nuclear reactors, reprocessing plants and similar installations with another tool useful in ensuring public safety. Krypton and xenon are markedly more soluble in liquid refrigerant-12 than argon, oxygen and nitrogen, especially at low temperatures. Thus, the first step in the absorption process involves contacting the contaminated air with the solvent at a low temperature and a high pressure so that most of the krypton and xenon will be dissolved in the liquid, leaving the air stream relatively free from radioactive components. The liquid stream is then sent to one or more fractionating-stripping units, operated at higher temperatures and lower pressures, where the absorbed krypton and xenon can be concentrated further and then revolatilized from the solvent for storage in cylinders or other treatment. Construction and installation of the pilot plant required for these studies have recently been completed, and a series of tests has been designed to encompass wide ranges of temperatures, pressures, and flows, as well as the use of higher temperature solvents. Preliminary pilot-plant results are presented and plans for future experiments are discussed. (auth)

**29125** RECOVERY OF XENON AND KRYPTON IN THE TREATMENT OF GASEOUS RADIOACTIVE WASTES. Slivnik, J. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). pp 315-21 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

In the course of investigations into the chemical recovery of radioactive krypton and xenon the possibility of a quantitative separation of both gases using fluorine as a reacting agent was studied. The influence of the reactants' mole ratios and reaction temperature on the synthesis of xenon fluorides is described. The results obtained during the study of the xenon-fluorine reaction kinetics are given. During this study 1 : 10 and 1 : 5 mole ratios of both reactants with an absolute pressure amounting to 33 atm at 22°C and temperatures of 110, 120, and 130°C were employed. It was found that under these conditions krypton does not react with fluorine and does not influence the xenon-fluorine reaction rate and direction. Experiments performed to remove traces of xenon from a bulk of krypton are described. (auth)

**29126** A STUDY OF CONTAINMENT SPRAYS AND CHARCOAL FILTERS FOR THE REMOVAL OF IODINE FOLLOWING A PWR LOSS OF COOLANT ACCIDENT. Nitti, D. A. (Babcock and Wilcox Co., Lynchburg, Va.). pp 573-85 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The radioiodine problem associated with the siting of the current generation of nuclear power stations in the United States is summarized and the effectiveness of containment spray systems and charcoal filter systems for the removal of the radioiodine following a PWR loss of coolant accident compared. The study showed that, based on the present reactor siting criteria in the United States, the ultimate iodine removal system must provide an iodine dose reduction factor (DRF) of 13 in the first two hours and then eventually achieve a DRF of 50. This means that about 2% of the iodine need never be removed from the containment atmosphere if the other 98% is removed sufficiently fast. The performance of iodine removal systems is shown as a function of operating time and design capacity. For removal systems operated in a recirculating mode, the system's iodine removal efficiency is relatively unimportant when compared with the effect of the presence of a small quantity of a penetrating component. The slow response time of a charcoal filter system limits the maximum dose reduction factor that can be practically obtained in the first two hours to between 5 and 8. However, the fast response of a containment spray system provides the capability of achieving an iodine dose reduction factor of about 50 within the first two hours after an accident. If a small quantity of a penetrating component is present, the charcoal filter system will eventually catch up to the spray system, and both systems will approach the same dose reduction factor. (auth)

**29127** ABSORPTION BY REACTIVE SPRAYS WITH APPRECIABLE LIQUID PHASE MASS TRANSFER RESISTANCE: THE WASHOUT OF METHYL IODIDE BY REACTIVE SPRAYS. Postma, A. K.; Schwendiman, L. C. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. pp 551-72 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The washout of organic iodides by reactive liquid sprays was studied. Although the reactive additive used in this study was hydrazine, the results would be applicable to other additives. Falling drop absorption was calculated, assuming surface saturation and first order reaction rates, for stagnant and well mixed drops. For drops having diameters smaller than about 500 $\mu$m, and for reaction velocities less than 100 $sec^{-1}$, the two models gave predicted removal rates which were similar. Computer evaluation of the infinite series solution to the absorption equation was carried out for a range of drop sizes, temperature, fall heights, and reaction velocities. Absorption by liquid wall films is an important part of the overall absorption for the spray systems described in this work. The penetration theory model of absorption into flowing films was used in this study to predict wall film absorption. The overall absorption model thus accounts for absorption by drops and wall film. The washout of methyl iodide by aqueous hydrazine sprays was measured in spray chambers approximately 4 ft in diameter by 10 ft tall. Measured washout half-times ranged from 8 minutes to several hours, depending on the spray rates, hydrazine concentrations, and temperatures. Collection of the drops and wall liquid permitted measurement of the relative importance of wall and drop absorption in these experiments. Based on the absorption model developed and the experimental results, the removal rate of methyl iodide in larger containment systems was predicted for a range of drop sizes, reaction velocities, temperatures, and vessel heights. (auth)

**29128** REACTOR CONTAINMENT SPRAY TECHNOLOGY PROGRAM. Row, T. H. (Oak Ridge National Lab., Tenn.). pp 587-603 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The design basis accident in water-moderated power reactors is a loss-of-coolant accident in which water sprays are generally employed to control the containment pressure transient by condensing the released steam-air mixture. Additives to the spray have been proposed as a way to increase their usefulness by enhancing the removal of various forms of radioiodine from the containment atmosphere. A program to investigate the gas-liquid systems involved is coordinated by ORNL for the US Atomic Energy Commission. A basic part of the program is the search for various chemical additives that will increase the spray affinity for molecular iodine and methyl iodide. A method for evaluating additives was developed that measures equilibrium distribution coefficients for iodine between air and aqueous solutions. Additives selected are used in single drop-wind tunnel experiments where the circulating gas contains iodine or $CH_3I$. Mass transfer coefficients and transient distribution coefficients have been determined as a function of relative humidity, temperature, drop size, and solution pH and concentration. Tests have shown that surfactants and organic amines increase the solution ability to getter $CH_3I$. Results from single drop tests help in planning spray experiments in the Nuclear Safety Pilot Plant, a large (~38 $m^3$) facility, where accident conditions are closely simulated. Iodine and $CH_3I$ removal rates have been determined for a number of solutions, including 1 wt % $Na_2S_2O_3$ + 3000 ppm B + 0.153 M NaOH and 3000 ppm B + 0.153 M NaOH. The additive has very little effect in removal of $I_2$ with half-lives of less than 1 min typical for any aqueous solution. These same solutions remove $CH_3I$ with a half-life of one hour. Analytical models for the removal processes have been developed. Consideration is also being given to corrosion, thermal and radiation stability of the solutions. Radiation studies have indicated the loss of $I_2$ equivalence, change in pH, solids formation, and $H_2$ generation for accident doses. The 1 wt % $Na_2S_2O_3$ + 3000 ppM B + 0.153 M NaOH produces $2.6 \times 10^{-1}$ $cm^3$/ml of $H_2$ at a dose of $4 \times 10^7$ R with a gas-to-liquid ratio of 25. Dose rate has no effect on the $H_2$ production under the same conditions, while the addition of 1 wt % [$NO_3^-$] reduced the $H_2$ production by a factor of 2. The study of $H_2$ generation has been expanded due to the relatively large amounts produced. (auth)

**29129** REMOVAL OF DUST FROM COMBUSTION GASES IN AN INCINERATOR FOR RADIOACTIVE WASTES. Sutra-Fourcade, Y.; Caire, B.; Gallissian, F. (CEA, Marcoule, France). pp 607-21 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968. (In French).

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

Incineration is a method of eliminating radioactive wastes which gives very large volume reduction factors. The purification of combustion gases from incinerators, however, raises numerous problems such as: high gas temperatures, acidity due to combustion of plastic materials, the presence of lampblack, etc. The characteristics of the aerosols formed and the behavior of the radioisotopes contaminating the wastes are studied, the incinerator of the Marcoule Centre being taken as a specific example. (auth)

**29130** FABRIC FILTRATION OF FLUE GASES FROM AN ACTIVE INCINERATOR: STUDIES ON DESIGN OPTIMIZATION AND OPERATIONAL ANALYSIS. Khan, A. A.; Amalraj, R. V.; Thomas, K. T. (Bhabha Atomic Research Centre, Bombay). pp 623-44 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The use of bag filters in the dry gas cleaning system of an incinerator as a safe and economical method for treatment of the flue gas from an incinerator burning low-level radioactive solid combustibles is described. Various types of fabrics were evaluated to find the filtration characteristics during the entire cycle of operation. Data on pilot plant studies carried out to optimize a suitable design of fabric filter for flue gas cleaning are included. Cost comparison of different fabrics based on the life of the fabric and the cost of fabric filtration per unit of solid wastes treated has been given. The physical, chemical and radiochemical natures of the aerosols encountered in various parts of the incinerator system are described. (auth)

**29131** STUDIES OF INCINERATOR AIR CLEANING SYSTEMS. Lee, K.; Lee, S. H.; Kim, D. J. (Atomic Energy Research Inst., Seoul). pp 645-58 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

Experimental results obtained with a small institutional radioactive waste incinerator and a gas cleaning system designed and constructed at the Korean Atomic Energy Research Institute are reported. The system consists of an incinerator with overfire and tangential air supply, a dilution valve, a two-stage cyclone collector, a heat-exchanger, a filter of domestic technical-grade glass fibre and an electrostatic precipitator for final collection of the particles within the flue gas. The particle collection efficiency of the gas cleaning units was measured and the distribution of the particle size at each unit was investigated. Sawdust charges with different concentrations of radioactive tracers, $^{198}Au$, $^{51}Cr$ and $^{35}S$, were burned and the radioactive concentrations at the downstream end of the system were measured. As a result of the experiment, the following units may be recommended as a standard incineration system for small laboratories or in countries where filters or electrostatic precipitators are difficult to obtain or expensive; (1) incinerator with tangential firing, (2) dilution valve, (3) two-stage cyclone collector, (4) roughening filter of technical-grade glass fibre. (auth)

**29132** FILTER FOR THE PURIFICATION OF HIGH-TEMPERATURE INCINERATOR GASES. Billard, F. (CEN, Fontenay-aux-Roses, France); Brion, J.; Cousin, M.; Delarue, R. pp 659-65 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968. (In French).

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

A recoverable filter for hot incinerator gases is described. This consists of metal foil cylinders on which asbestos fibres have been deposited by pneumatic spray to constitute the filtering medium. The special feature of its operation lies in the fact that partially burned materials from the incinerator, especially lamp black, complete their combustion on the filter, as they are produced. This greatly reduces choking of the filters, which are expected to operate for several hundreds of hours between cleanings. This filter has been tested on a reduced-scale model followed by a long period of industrial use in a pilot plant with a capacity of 20 kg/hr. The plant and the results obtained are described. (auth)

**29133** DESIGN AND CONSTRUCTION OF AIR PURIFICATION SYSTEMS IN FRENCH NUCLEAR INSTALLATIONS. Guiriet, J.; Duverger de Cuy, G.; Salle, R. (CEN, Saclay, France). pp 669-82 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968. (In French).

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The fission products present in nuclear installations create a potential hazard of environmental contamination against which precautions must be taken. This is specifically the purpose of purification equipment. The first problem is to define the containment and its leakage rate. The efficiency of purification on the off-gas system must be adapted to the hazard and the choice will be guided by the characteristics of the site, in particular the weather conditions and the doses regarded as acceptable for the surrounding population. Purification systems will accordingly vary depending on the type of installation in which they are to be used (reactors, factories, laboratories). The different possibilities are described. Systems which are both effective and adaptable can be built. Durability of equipment properties, and the additional hazards entailed in handling purification equipment, and the accidents which could result from its use are described. The financial aspects of the different solutions are also discussed. (auth)

**29134** AIR-CLEANING OPERATIONAL EXPERIENCE IN THE BHABHA ATOMIC RESEARCH CENTRE, TROMBAY. Ramarathinam, K.; Khan, A. A.; Subramaniam, K. G.; Amalraj, R. V.; Thomas, K. T. (Bhabha Atomic Research Centre, Bombay). pp 683-93 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

Details of the operational experience gathered in the Bhabha Atomic Research Centre on various aspects of the problem associated with the control of pollutants from the operation of nuclear facilities are discussed. A short account of the standards for ra-

dioactive gaseous waste management and the general practices concerning the prevention and control of air contamination is given. Studies on airborne radioactivity and the operational experience of the ventilation systems connected with some of the installations at Trombay are reviewed. The cost aspects of a typical ventilation system of an operating plant are presented. (auth)

**29135** AIR CLEANING AT THE USAEC Y-12 PLANT. Little, J. C. (Union Carbide Corp., Oak Ridge, Tenn.). Contract W-7405-eng-26. pp 695-724 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

Some of the air-cleaning requirements of production, research, development, and biological facilities in the Y-12 area were described. Problems and their solutions in hazardous-material containment, air cleaning, contamination control, and air pollution control are enumerated. Bioclean and laminar-flow clean rooms, germ-free supply air systems, exhaust systems for handling toxic and radioactive materials, virus containment and exhaust facilities are described. The Plant's practices regarding air cleaning are discussed including standardization of specifications for high-efficiency particulate air-filters and mounting frames, DOP testing of air filter systems, and the replacement of sub-standard filter installations. (auth)

**29136** RADIOLOGICAL CONTROL OF GASEOUS WASTES AT THE UP2 PLANT. Bougeois, P.; Scheidhauer, M. J. (CEA, Cherbourg, France). pp 725-41 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968. (In French).

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

A brief account of the organization and purposes of the La Hague Centre is given and more particularly of the UP2 industrial facility. An inventory of possible sources of air contamination due to the Centre's activities was drawn up and the characteristics of extraction and removal in the UP2 stack are described. The local weather conditions are briefly discussed and the results of an experiment in which a uranin aerosol (the sodium salt of fluorescein) was released through the UP2 stack—in September and October 1965—were examined. The methods of control adopted at the La Hague Centre and the different types of equipment installed at the monitoring points are described. The results of control of gaseous effluents released from the UP2 unit during several operational runs were analyzed. (auth)

**29137** EXPERIMENTS BY THE MEXICAN NNEC ON THE CONTROL OF AIRBORNE RADIOACTIVE CONTAMINATION. Bravo S., E. (Comision Nacional de Energia Nuclear, Mexico City). pp 743-51 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968. (In Spanish).

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The installations of the Mexican National Nuclear Energy Commission have to deal with the problem of environmental contamination caused by dust and aerosols suspended in the air and originating mainly with such uranium-bearing ores as tyuyamunite, carnotite, betafite, technical-grade sodium uranate, ammonium uranate concentrate, uranium tetrafluoride and uranium dioxide. To prevent environmental contamination by these radioactive materials, the Commission has experimented with three different systems, based on the principle of extracting the dust from the environment, passing it through a cyclone system, separating the particles of larger size and controlling the small particles or aerosols by means of filtration, dilution in liquid columns and dilution in liquid curtains. On the basis of the results obtained, plans have been made for supplementing the systems with an adsorption column and an ion exchange column, depending on the specific requirements of each laboratory. (auth)

**29138** OPERATING EXPERIENCE WITH AIRBORNE ACTIVITY CONFINEMENT SYSTEMS AT THE SAVANNAH RIVER PLANT. Hinton, J. H.; Temple, C. J. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. pp 753-61 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

Equipment was installed in the ventilation exhaust system of each reactor building at the Savannah River Plant to collect and confine airborne radioactive particles and halogen vapors that might be released in a reactor accident. The equipment is continuously on-line and has been in service five years. The activity collection system in each reactor building consists of four active compartments and one spare. Each compartment contains banks of 20 moisture separators, 32 filters, and 32 beds of activated carbon in series and is designed for 32,000 cfm air flow. The moisture separators, which prevent moisture damage to the filters, are woven Teflon stainless steel mats and are steam cleaned approximately every nine months to remove accumulated oily materials and particles. No moisture separators have required replacement. The filters are pleated glass-asbestos felt, protected against mechanical damage by wire mesh on both filter faces. Upon installation, each new filter is tested with a 0.6-μm dioctyl phthalate aerosol. Any filter with a leak greater than 0.05% is replaced. Service life for filters is approximately 16 months. The condition of the moisture separator and filter banks in each compartment is determined weekly by measuring the pressure drop across each bank and the air flow rate through the bank. The activated carbon beds in each compartment are for removal of iodine-131. Carbon bed banks are leak-tested with Freon-112 annually and after replacement. After about four years of service, seventeen of the 20 banks tested in 1967 were within the maximum leakage specification of 0.09%. Three banks, with leakage up to 0.16%, were replaced in 1967. Five of the 17 with satisfactory leakage rates were replaced because of corrosion of the enameled or cadmium-plated mild steel frames. Replacement carbon beds now have stainless steel frames. (auth)

**29139** CONTROL OF AIRBORNE WASTES FROM UNITED KINGDOM GAS COOLED POWER REACTORS. Dale, G. C. (Central Electricity Generating Board, London). pp 785-92 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

United Kingdom has in operation 23 carbon-dioxide-cooled nuclear power reactors. The main features of a typical reactor are described, and the ways in which airborne wastes arise are detailed. The first eight power stations employ reactors in steel pressure vessels and the biological shield is air cooled. This air becomes activated by the action of thermal neutrons and radioactive isotopes of both true gases and finely divided particulates are produced. Additionally some leakage of the coolant gas takes place and this, as well as the ventilation of active handling facilities, adds to the main source of effluent. In the case of reactors with prestressed concrete pressure vessels the cooling is achieved by circulating water through pipes close to the internal steel liners, and cooling-air problems are thus eliminated. The quantities, isotopic composition and origins of the various contributions to the final discharge are given. Treatment consists of filtration and dispersal through stacks at reactor roof height. The filters used are described. Measurements are made by sampling the main gas circuit which is continuously filtered, by sampling a fraction of the exhaust gases before discharge to the atmosphere and as a precaution a minimum program of environmental samples are checked. In the event of an emergency where relatively large quantities of fission products may be involved extra equipment is provided to reduce the emission of radioactive materials to acceptable levels. (auth)

**29140** UNITED STATES EXPERIENCE IN MANAGEMENT OF GASEOUS WASTES FROM NUCLEAR POWER STATIONS. Goldman, M. I. (NUS Corp., Washington, D. C.). pp 763-83 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

Management of gaseous wastes from nuclear power stations has been a matter of concern to the regulatory arm of the U.S. Atomic Energy Commission and to the electric utility companies responsible for the safe operation of these stations. Operating experience for eight nuclear generating stations has been accumulated and evaluated in terms of system performance, atmospheric dilution and environmental consequences. The results of this study show that the management of gaseous wastes from nuclear power stations has without exception been well below those levels of radioactivity which would exceed the standards of Title 10, Code of Federal Regulations, Part 20. The major factor influencing waste gas emissions has been the performance of fuel cladding, with stainless-steel-clad fuel exhibiting a significantly greater tendency for defects and consequent escape of fission gases. The significance of meteorological parameters for specific reactor sites is also examined. (auth)

**29141** MEASUREMENT OF $^{41}Ar$ ACTIVITY DISCHARGED FROM THE SHIELD COOLING AIR OF MAGNOX REACTORS. Holmes, R. E.; Halliday, P.; Mathias, D. J. (Atomic Power Constructions Ltd., Sutton, Eng.). pp 19-31 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The early magnox reactors built in the United Kingdom utilized steel pressure vessels surrounded by concrete biological shields. Cooling of these shields is achieved by means of large volumes of atmospheric air. Argon in the air is activated by the $^{40}Ar(n,\lambda)^{41}Ar$ thermal neutron reaction. Low-cost portable equipment was designed to measure the specific activity of this shield-cooling air. Calibration of the equipment was achieved by means of a 5-$cm^3$ ampoule of argon activated in BEPO. The calibrated equipment was utilized to measure the specific activity of shield-cooling air discharged from Bradwell, Calder Hall, Hunterston, Trawsfynydd and Tokai Mura power stations. (auth)

**29142** RESEARCH AND DEVELOPMENT ON COATINGS FOR RETAINING FISSION PRODUCT IODINE. Genco, J. M.; Berry, D. A.; Rosenberg, H. S.; Cremeans, G. E.; Morrison, D. L. (Battelle Memorial Inst., Columbus, Ohio). Contract W-7405-eng-92. pp 485-505 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

Elemental iodine has the propensity for forming charge-transfer complexes with amines. These complexes are stable at ambient temperatures and retain much of this stability at elevated temperatures. Amines also react with methyl iodide and hydrogen iodide to form the quarternary ammonium salts and amine salts, respectively. These chemical properties of amines provide the basis for the development of retentive coatings for fission product iodine. Various amine-containing polymers were studied in steam-air environments at elevated temperatures using dilute quantities of tagged iodine. Both non-condensing and condensing steam conditions were investigated. Several of the polymers showed sorption rates and capacities that would be adequate for the chemical removal of accident-released fission-product iodine and were several times more effective than commercial protective coatings currently being used. The removal capabilities for amine polymers also could be enhanced by impregnating the reactant on a matrix material such as asbestos mat, presumably because the impregnation technique leads to enhanced surface area and porosity. The two most promising coating systems were 1,10-phenanthroline impregnated upon asbestos and a three component composite film of the copolymer of Genamid 2000 and Epon 828 as a reactive binder with 1,10-phenanthroline as a reactive filler. The use of a reactive coating as a passive safety system should reduce appreciably the airborne iodine half-life and the hazards associated with iodine release during a nuclear reactor accident. (auth)

**29143** REACTANTS FOR THE REMOVAL OF IODINE AND METHYL IODIDES AND THEIR APPLICATION IN FOAMS. Viles, F. J. Jr.; Bulba, E.; Lynch, J. L.; First, M. W. (Harvard School of Public Health, Boston). Contract AT(30-1)-841. pp 507-30 of Treatment of Airborne Radioactive Wastes. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

The encapsulation of contaminated air by stable, reactive foams is potentially an efficient method for cleaning air because of large surface areas and long reaction times. Contained atmospheres encapsulated by foam demonstrate significant reductions in leakage. Addition of hydrazines to water based foams provided high removal rates for elemental iodine. A 0.11 M concentration of unsymmetrical dimethyl hydrazine (UDMH) in foam resulted in iodine reductions of 99 and 99.97% within 12 and 18 minutes, respectively. Screening tests of reactive foam solutions for removal of gaseous methyl iodide were made under static and dynamic (shaking) conditions and included the following reactants: hydrazine, UDMH, piperazine, tri-n-butylphosphine (TBP), triethylenediamine and thioacetamide. In the dynamic tests, $\frac{1}{3}$ to $\frac{1}{4}$ molal concentrations of the latter three reactants in an alkaline foam solution containing $\frac{1}{3}$ molal UDMH required 7, 14 and 28 minutes, respectively, to reduce methyl iodide to 1% of the initial concentration (1 to 7 ppM). The other reactants were less effective by comparison. Water-foam encapsulation studies for air containing 0.8 to 2.0 ppM methyl iodide showed removal rates not significantly different from those found in the static screening tests for the same reactants, even though reactive surface areas were 20 to 100 times greater after foaming. This suggests that there is an absence of reactant in the foam bubble film probably caused by displacement by surfactants in the foaming agent. High removal rates of elemental iodine by hydrazine-type foams and of methyl iodide by TBP-containing foams are explained by noting that, in these cases, gas-phase rather than liquid-phase reactions are involved and that the foam bubble surfaces are collecting surfaces for the formed aerosol particles. (auth)

## Vacuum Engineering

*Refer to abstracts 29258 and 29259.*

# INSTRUMENTATION

## Radiation Detection Instruments

### *General Detectors and Monitors*

*Refer also to abstracts 28996, 29141, 29562, and 30640.*

**29144** (AD-683701) NaI(Tl) TOTAL ABSORPTION DETECTOR FOR ELECTRONS AND GAMMA-RAYS AT GeV ENERGIES. Hofstadter, R.; Hughes, E. B.; Lakin, W. L.; Sick, I. (Stanford Univ., Calif. High-Energy Physics Lab.). Dec. 1968. Contract Nonr-225(67). 15p. (HEPL-579). CFSTI.

A new and successful demonstration of the use of total absorption shower detectors for electrons and gamma-rays in the GeV energy range is reported. Such detectors have the following attractive properties: (a) 100% detection efficiency, (b) good energy resolution and (c) large dynamic range. Moreover, there is virtually no upper limit to the energy detectable by this means because the size of the detector varies only logarithmically with the energy of the incident electron or gamma-ray. (auth) (USGRDR)

**29145** (AD-683706) HIGH RESOLUTION WITH NONDISPERSIVE X-RAY SPECTROMETERS. Aitken, D. W. (Stanford Univ., Calif. High-Energy Physics Lab.). July 1968. Contract AF49(638)-1499. 23p. (HEPL-569). CFSTI.

A research effort was carried out with the aim of acquiring a better understanding of the processes leading to the detection of x rays in silicon and germanium, as well as in alkali halide scintillation crystals. Results of this research, as well as of the work of other groups, now enables one to make a comparison of detectors for high resolution nondispersive x-ray analysis, and to draw some conclusions concerning what to expect in the future. The present article is limited to a discussion of resolution in the x-ray energy region. This region spans the energy range from about 1 to 100 keV. This in turn corresponds to the wavelength region extending from about 10 Angstroms down to about 0.1 Angstroms. (USGRDR)

**29146** (AEEW-M-881) PROGRESS IN THE APPLICATION OF SOLID-STATE TRACK RECORDERS TO REACTOR PHYSICS EXPERIMENTS. Besant, C. B.; Ipson, S. S. (Atomic Energy Establishment, Winfrith (England)). Mar. 1969. 39p. Dep. CFSTI. UK 6s. 0d.

Strain energy fields produced by heavily ionizing particles passing through insulating materials may be observed directly with an electron microscope or, after etching, the tracks may be seen with an optical microscope. This technique was applied to detecting fission fragments from fissions taking place in a thin source of fissile material. The source, together with the insulating material, is termed a solid-state track recorder and was applied to the measurement of fission ratios in the fast critical assembly ZEBRA at Winfrith. The main disadvantage of the technique has been in counting tracks by eye, which is laborious and subject to the human element. This has been overcome by counting tracks with a Quantimet-Computer Image Analyzer. Absolute fission rate measurements are also discussed, and it has been found that measurements to an accuracy of better than ±1% should be possible with this technique. (auth)

**29147** (AWRE-O-15/69) THE DETERMINATION OF NATURAL RADIOACTIVE IMPURITIES IN THE RAW MATERIALS OF $^{6}$Li LOADED CERIUM SCINTILLATION GLASSES AND THEIR REMOVAL. O'Connor, L. P. (Atomic Weapons Research Establishment, Aldermaston (England)). Apr. 1969. 14p. Dep. CFSTI. UK 2s. 6d.

Raw materials for the production of neutron-detecting lithium-loaded cerium scintillation glasses were found to contain naturally occurring radioactive nuclides at levels which invalidated the use of the glasses in low-geometry detecting systems. The estimation of the radioactive species in the materials is described, and an account is given of the purification procedures used and the decontamination achieved by them. (auth)

**29148** (DESY-69/12) SECONDARY ELECTRON EMISSION OF METAL FOILS IN THE ENERGY RANGE OF 1,5-7 GeV. Raquet, E. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Mar. 1969. 18p. Dep.

The secondary emission properties of single metal foils were investigated for the purpose of designing a secondary emission monitor with a minimum scattering length. The more basic behavior of the secondary emission is considered. For an understanding of the emission from thin metal foils two results seem to be important: The ratio of the secondary emission from the beam entrance surface of the foil to that from the beam exit surface is roughly 2:1. In agreement with a previous theoretical treatment the emission from the entrance surface depends on the primary energy, while the emission from the exit surface is independent. Some applications are briefly described. (auth)

**29149** (ORNL-TM-2579) REVISED ZERBY-MORAN CODE FOR CALCULATING THE RESPONSE OF SODIUM IODIDE CRYSTALS TO GAMMA RAYS. Rodda II, John L. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 41p. Dep. CFSTI.

A description is given of the input format and output features of a revised version of the Zerby-Moran code for calculating the response of sodium iodide scintillators to gamma rays of energies up to 10.22 MeV. Two versions of the code (called MØRN) are available, one for the CDC 1604-A computer and one for the IBM 360/75 (ORNL compiler). Output options include 8½ by 11 inch semi-log plots (histograms) of the unbroadened Compton spectrum (without the effects of secondary radiations) and of the total response spectrum (including the effects of detector resolution). A plot of the unbroadened Compton spectrum (with secondaries) with error flags is also available. The printed output includes not only the intrinsic efficiency and the photofraction but also the first and second escape peak efficiencies. A complete guide to the use of a versatile plotting package (SKETCH) is also given. This package can be used independently of the MØRN code and will run on either the CDC 1604-A or the IBM 360/75 computer. Both the CDC 1604-A and IBM 360/75 versions of the code as well as the plotting package are available from G. T. Chapman, Neutron Physics Division, ORNL. (auth)

**29150** (RISO-M-867) OPTIMUM COUNT-RATE ESTIMATE FOR A POISSON PULSE TRAIN. Drab, F. (Danish Atomic Energy Commission, Risoe, Research Establishment). Mar. 1969. 28p. Dep.

The method described treats the measurement of a parameter of a Poisson pulse train as a statistical decision, i.e., a hypothesis test which leads to measurement optimization from the point of view of time and accuracy. This method is compared with the existing measurement methods, and a number of possible applications are discussed. Some numerical relations for the symmetrical binary test are developed. (auth)

**29151** IMPROVEMENTS IN METHODS OF LIQUID SCINTILLATION AND IN DEVICES FOR CARRYING OUT THE SAID METHOD. Jordan, Pierre (to Picker Corp.). British Patent 1,152,985. May 21, 1969. Priority date June 26, 1965, Switzerland.

An improved method for liquid scintillation counting which employs the external standard technique is described. The procedures for quench calibration for determining the counting efficiency for each sample are given. Block diagrams of the liquid scintillation spectrometer are included. (W.H.K.)

**29152** IMPROVEMENTS IN OR RELATING TO RADIATION SCANNING RECORDERS. Woller, Peter (to Medizinische Akademie "Carl Gustav Carus"). British Patent 1,151,758. May 14, 1969. Filed Oct. 10, 1966.

A system is described for the scintigraphic representation of the distribution of radioactive materials within the human body whereby the output of a scintillation counter-radiation measuring device is connected to a plurality of printing systems by electronic means which serves to intensify the contrasts of the printed record by increasing the number of pulses fed to the printing systems in areas of dense radioactivity and decreasing the number of pulses in less dense areas. Each printing system is arranged to have a different degree of contrast intensification. A number of variants of the system are described. (UK)

**29153** MEDICAL USES OF WHOLE-BODY COUNTERS. Remenchik, Alexander P. (Loyola Univ., Hines, Ill.). Med. Clin. N. Amer., 53: 205-10 (Jan. 1969).

Types of whole-body counters in use, their calibration, and their applications are reviewed. Applications fall into 3 broad categories: radiation protection monitoring, measurements of body content of K, and low-level tracer work. Levels of radioactivity 1000 μCi less than the recommended maximal permissible body burdens are readily detected by whole-body counters. For certain contaminants retained and excreted at exceedingly low levels, only a whole-body counter readily indicates the presence of such contaminants in the body. For example, personnel working in the vicinity of nuclear reactors have been observed to be contaminated with $^{51}$Cr, $^{58}$Co, $^{60}$Co, $^{65}$Zn, $^{95}$Zr, $^{110}$Ag, $^{131}$I, and $^{141}$Ce. Increasing use of nuclear

reactors will require extensive monitoring programs of populations exposed to these devices. Low-level tracer work represents the greatest potential application of whole-body counters in clinical medicine. Metabolic studies can be simplified considerably by the application of whole-body counters to the study of human disease. In the use of the bone-seeking radioisotopes of Sr and Ca to study disorders of the human skeleton the whole-body counter has made it possible to use tracer doses. Results with whole-body counters have correlated well with other data. Whole-body counters can be used to obtain the biological data necessary for the calculation of radiation doses. The entire injected dose of a radiopharmaceutical must be accounted for. Losses from the body can be easily detected by this technique. (BBB)

**29154** INDEPENDENT RADIATION MONITOR (I.R.M.). Kroening, Paul M.; Mucha, Raymond (Scott and White Clinic, Temple, Tex.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 900-2(Apr. 1969).

Design and construction of an ionization chamber and circuits to switch on a light bulb when a preset level of radiation is attained in a radiation therapy room are described. (W.H.K.)

**29155** CONTRIBUTION TO METHODS FOR STUDY OF THE DETECTION OF HEAVY IONS IN CELLULOSE NITRATE. Tripier, Jacques; Debeauvais, Monique; Stein, Roland; Ralarosy, Jarno (Centre de Recherches Nucleaires, Strasbourg). J. Microscop., 7: 811-24(Nov. 1968). (In French).

The use of polymers to record ionizing particles was investigated employing $\alpha$ particles (2.5 MeV) from $^{210}$Po, oxygen ions accelerated in a Van de Graaff machine to 40 MeV, sulfur ions accelerated to 50 MeV, and fission fragments of $^{252}$Cf with a mean energy of 90 MeV. Nitrocellulose films were prepared from amyl acetate solutions. It was shown that this material can be used to detect heavy ions. Ionizing particles give rise to damage in the molecular lattice along their range. This damage can be preferentially etched by means of a suitable chemical reagent. In this study oxidizing agents and strong bases were used to attack the degraded zones in the cellulose nitrate film. Thus by controlling the temperature and concentration of NaOH solutions the degree of etching could be varied. Details are given on track development parameters and the chemical etching process. The dependence of the track appearance on the energy loss of the ions was also investigated. For $\alpha$ particles, sulfur and oxygen ion tracks, and $^{252}$Cf fission fragments, good discrimination for the different tracks registered in cellulose nitrate was obtained. (BBB)

**29156** ENERGY RESPONSE OF A MODERATED NEUTRON DETECTOR. Cavallari, F. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy); Terrani, M. Energ. Nucl. (Milan), 16: 400-2(June 1969).

The energy response of a boron trifluoride proportional counter for water-moderated fast neutrons was studied as a function of source–detector distance and geometry. Neutron sources from 0.025 to 14.1 MeV were used. (W.H.K.)

**29157** ELECTRON–ION RECOMBINATION IN THE TRACK OF AN IONIZING PARTICLE AND THE SCINTILLATION MECHANISM OF NOBLE GASES. Dolgoshein, B. A.; Lebedenko, V. N.; Rogozhin, A. M.; Rodionov, B. U.; Shuvalova, E. N. (Moscow Engineering-Physics Inst.). Zh. Eksp. Teor. Fiz., 56: 1152-60 (Apr. 1969). (In Russian).

The role of electron-ion recombination in scintillation of noble gases is established experimentally. A scintillation mechanism based on the formation, radiation emission, and de-excitation of noble gas molecules in the ionizing particle track is considered. (auth)

**29158** RECORDING OF MOESSBAUER EFFECT BY MEANS OF X-RAY FILM AND WITH CADMIUM SULFIDE RESISTANCES. Bonchev, T.; Danov, A. (Sofia Univ.). Compt. Rend. Acad. Bulg. Sci., 21: 1045-8(1968).

Results of an investigation on the use of ordinary x-ray film and the cadmium sulfide resistance concept for recording of Moessbauer spectra are presented. (B.G.D.)

**29159** INVESTIGATION OF THE OPTIMUM GEOMETRY OF $^{40}$K MEASUREMENTS WITH A SPECTROMETER FOR HUMAN BODY RADIATION. Sivintsev, Yu. V.; Yuzgin, V. S. At. Energ. (USSR), 26: 344-7(Apr. 1969). (In Russian).

Using the Monte Carlo method the response was calculated for a large NaI crystal used for registration of gamma rays from $^{40}$K, uniformly distributed in a phantom. The program, written for the Mzo computer, was used for determining the gamma-ray relaxation factor, the amount of quanta registered by the crystal, the amount of quanta in the photopeak region and in the rest of the spectrum as a function of crystal disposition over the phantom and of crystal height. The received functions provided an optimum scheme of the disposition of four detectors with NaI crystals 104 × 100 mm for gamma-ray registration of the isotope $^{40}$K contained in a body with a reliability of 0.95 for a period of 3 min. (auth)

**29160** VISUAL IMAGING OF TRACK-ETCHED PATTERNS. Alter, Henry Ward (to General Electric Co.). British Patent 1,152,032. May 14, 1969. Priority date Oct. 20, 1966, United States.

A method of producing a visual image of a pattern of holes through a sheet of track-etched material, comprising the steps of positioning a sheet of receptor material in face-to-face contact with the track-etched sheet; applying a marking fluid to the track-etched sheet to flow through the holes into contact with the receptor sheet, whereby the marking fluid is deposited in a pattern of dots on the receptor sheet to produce a visual image of the hole pattern. (B.G.D.)

**29161** AMPLIFIER WITH DRIFT COMPENSATION UTILIZING FIELD-EFFECT TRANSISTORS. Malosti, D. (CNEN, Rome). Energ. Nucl. (Milan), 16: 403-4(June 1969). (In Italian).

An amplifier with drift compensation utilizing field-effect transistors is proposed for use in an electrometer-amplifier system for measuring the current from ionization chamber used for neutron flux measurements. (B.G.D.)

**29162** THIN WINDOWS FOR FLOW PROPORTIONAL COUNTERS IN X-RAY FLUORESCENCE SPECTROMETERS. Brown, G.; Kanaris-Sotiriou, R. (Rothamsted Experimental Station, Harpenden, Eng.). J. Phys., E (London), 2: 551-2(June 1969).

Makrofol KG, the polycarbonate of 4.4′-dihydroxydiphenyl-2.2′-propane, which can be obtained as 2 $\mu$m thick film, is suitable for flow proportional counter windows. When correctly fitted it is durable and, of commercially available films, has the largest transmission for the K-radiation of the light elements, Z = 11–16. (auth) (UK)

**29163** A SOURCE OF 3.85-MeV GAMMA RAYS FOR TESTING Ge(Li) DETECTORS. Litherland, A. E.; Alexander, T. K.; Jeffs, A. T. (Chalk River Nuclear Labs., Ont.). Can. J. Phys., 47: 1061-4(May 15, 1969).

Mono-energetic 3.85-MeV gamma rays, and lower energy gamma rays, have been produced in a source consisting of an intimate mixture of $^{10}$B and $PuO_2$. Levels in $^{13}$C are excited by the $^{10}$B$(\alpha,p\gamma)^{13}$C reaction and the Doppler broadening of gamma rays from the 3.85-MeV level is attenuated, since its lifetime is long compared with the slowing-down time of $^{13}$C ions in the source material. When observed with a particular 15-cm$^3$ Ge(Li) detector, the 3.85-MeV full-energy peak had a width of 4.5 keV (fwhm), consistent with no Doppler broadening. The measured energy of the gamma ray from the third excited state of $^{13}$C is 3854 ± 1 keV. The branching ratios I(3854 → 3090)/I(3854 → 0) = 2.5 ± 0.5 × $10^{-2}$ and I(3854 → 3685)/I(3854 → 0) = 0.55 ± 0.03 have been determined using the source. (auth) (CAN)

**29164** IDENTIFICATION OF FISSION FRAGMENT TRACKS IN LEXAN AFTER PREIRRADIATION TO HIGH DOSES OF ALPHA PARTICLES. Stone, D. R. (Oak Ridge National Lab., Tenn.). Health Phys., 16: 772-3(June 1969).

It was shown that charged particles other than fission fragments produce visible tracks in chemically etched Lexan, these tracks being caused by recoiling carbon atoms. This may give rise to the making of fission fragment tracks in dosimetric applications. It was found that when Lexan previously exposed to an alpha particle fluence as high as $10^{12}$/cm$^2$, was exposed to fission fragments the latter were registered with an efficiency of within 1% of that with no previous alpha exposure. There was therefore no decrease in the critical angle of detection. The irradiation increases the etchability of the Lexan surface. For this reason the material should be etched for short periods and inspected between etchings when determining the number of fission fragment tracks in foils which have been pre-irradiated with charged particles or photons, in order to prevent overetching. The optimum etch time for Lexan with previous alpha exposure is less than 30 min., the time decreasing with increased alpha exposure. The fission fragment tracks are distinguishable by their cigar-like shape; alpha particles cause smaller circular pits. (UK)

**29165** ALPHA AIR MONITOR FOR $^{239}$Pu. Gupton, E. D. (Oak Ridge National Lab., Tenn.). Health Phys., 16: 808-10 (June 1969).

It is pointed out that the monitoring of air for $\alpha$-emitters more hazardous than $^{222}$Rn and its daughters is complicated by the universal presence of radon in the air near the surface of the earth, and the variability of the concentration of these radon nuclides. The MPC for $^{239}$Pu in air is equivalent to 4.4 dis/min/m$^3$, while that for $^{222}$Rn plus daughters is 6.6 × $10^4$ dis/min/m$^3$. In many lo-

calities the radon daughters may reach a concentration which, in terms of dis/min, is equivalent to several hundred times the MPC for $^{239}Pu$, although this concentration is only about 1% of the MPC for radon plus daughters. Some of the detectable differences between radon daughters and $^{239}Pu$ are that (a) the alpha particles are of different energies, (b) decay of radon daughters is accompanied by $\beta$-emission, and (c) the half-lives of radon daughters are much shorter than for $^{239}Pu$. A practical air monitor is described, which is based on the alpha-to-beta particle emission ratio. It is relatively simple in design and moderate in cost, and will, except in explosive-type releases of activity, provide information adequate to control acute exposures to airborne $^{239}Pu$ to within less than 2% of the quarterly MPE. It discriminates most of the more hazardous $\alpha$-emitters from naturally occurring materials, and is not affected by low level radiation. It responds to both $\alpha$- and $\beta$-radioactivity, with separate read-out and alarm, and thus may be used for monitoring both types of hazards. (UK)

**29166** HUMAN BODY SCANNER. Donato, Luigi; Gennaro, Gianni; Giordani, Roberto (to EURATOM). British Patent 1,152,392. May 14, 1969. Priority date Aug. 17, 1965, Italy.

A radioisotope scanner for human body radiodiagnosis is described which comprises a plurality of scintillation counters arranged in pairs, the counters of each pair being held in axially aligned opposition one with respect to the other, the axes of the pairs being all perpendicular to the plane of a bed for the patient and in which the pairs are mounted respectively on separate carriages movable longitudinally and transversely with respect to the bed in a plane parallel to the plane of the bed. In a preferred form of the invention, all three radiodiagnostic processes, i.e., profile scanning, zone scanning and body scanning, can be effected completely automatically with one and the same apparatus. (B.G.D.)

**29167** A NEW METHOD OF MEASURING THE RESPONSE OF A $4\pi\beta$-COUNTER TO $\gamma$-RAYS AND INTERNAL CONVERSION ELECTRONS. Kawada, Y. (Electrotechnical Lab., Tokyo). Int. J. Appl. Radiat. Isotop., 20: 413-22(June 1969).

Precise measurements of the response of a $4\pi\beta$ gas counter to $\gamma$-rays and internal conversion electrons were performed by combining $4\pi\beta$-$\gamma$ and $2\pi\beta$-$\gamma$ coincidence measurements. This method requires no additional absorber and the measurements can be made without changing any physical parameter. The method offers a significant improvement in counting statistics in addition to a considerable reduction of the error due to spurious pulses, noise, radioactive contaminants and background fluctuations provided that the two sets of coincidence measurements are recorded simultaneously by the use of a double channel $\beta$-counting system. The $\gamma$-ray response, measured as a function of $\gamma$-ray energy, was in general agreement with data obtained by Williams and Campion, and Merritt and Taylor. Measurements were also made to demonstrate the effects of the type of gas used and the size of the diaphragm between the two halves of a $4\pi$-counter. These results show that the latter effect can make a major contribution to the intrinsic $\gamma$-sensitivity of the $4\pi\beta$-counter. The $\gamma$-sensitivity of the $4\pi\beta$-counter with a source sandwiched between absorbers, and the response to the internal conversion electrons from $^{203}Hg$, were also measured. (auth) (UK)

**29168** EXCIMER SCINTILLATORS. Carter, J. G.; Christophorou, L. G. (to United States Atomic Energy Commission). U. S. Patent 3,444,089. May 13, 1969.

In this patent, liquid scintillators are formulated with a solvent which forms excimers. Two such solvents are 1,6-dimethylnaphthalene and 2-ethylnaphthalene, for example. Use of such solvents in liquid scintillators enhances energy transfer from solvent to solute, minimizes the quenching effect caused by quenching materials in the scintillators, and permits detection of weaker radiation while at the same time permitting the use of smaller volumes of the scintillators and providing for a substantial improvement in detection efficiency.

**29169** PROPAGATION OF STATISTICAL COUNTING ERROR TO THE PARAMETERS OF A LORENTZIAN. Shnidman, R. (Johns Hopkins Univ., Baltimore). Nucl. Instrum. Methods, 71: 111-12(1969).

It is shown that under some general conditions the uncertainties of least-squares fitted parameters can be estimated before the data are accumulated. Special cases concerning Lorentzian absorption lines are considered in detail. (auth)

**29170** EFFECTS OF ZONE REFINING ON THE PULSE HEIGHT AND PULSE SHAPE OF ANTHRACENE, TRANS-STILBENE, AND P-QUATERPHENYL CRYSTAL SCINTILLATORS. Perdue, P. T.; Brown, M. D. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods, 71: 113-16(1969).

Stilbene, anthracene, and para-quaterphenyl have been prepared in high purity by zone refining. Improvements in the light output of each material were noted. The light outputs relative to the Compton edge in NaI(Tl) were 27% for stilbene, 85% for anthracene and 92% for para-quaterphenyl. (auth)

**29171** MEASUREMENT OF NUCLEAR INTERACTIONS IN PLASTIC SCINTILLATORS. Baker, C. A. (Rutherford High Energy Lab., Chilton, Eng.); Bonner, B. E.; Blair, I. M.; Brady, F. P.; Edgington, J. A.; Howard, V. J. Nucl. Instrum. Methods, 71: 117-20(1969).

A measurement of the tail-to-peak ratio has been made for protons incident on NE102A. For a cut 5 MeV below the peak, the ratio is 1.00 ± 0.03% and 3.04 ± 0.11% at 25.3 and 46.0 MeV respectively. (auth)

**29172** SHIELDING OF WHOLE BODY COUNTERS. Schmier, H. (Bundesgesundheitsamt, Berlin). Kerntechnik, 11: 227-9(Apr. 1969). (In German and English).

After a brief survey of the uses and of the shielding of whole-body radiation count facilities, the research work carried out for the purpose of achieving an effective shielding at a low cost is described. It is shown that the cost of an effective shielding can be substantially reduced by an appropriate choice of building materials. (auth)

**29173** RADIAL DISTRIBUTION OF PHOTONS BACKSCATTERED FROM THE SURFACE OF SEMI-INFINITE SCATTERER. Nakamura, Takashi; Hyodo, Tomonori (Kyoto Univ.). J. Nucl. Sci. Tech. (Tokyo), 6: 143-52(Mar. 1969).

The radial distribution of photons backscattered in the direction perpendicular to the front face of a semi-infinite scatterer was examined for the case of a point isotropic $\gamma$-source placed on the scatterer. As a result, the following relations were found: $N_n(r) = \alpha(e^{-a_n r}/r)$, $I_n(r) = \beta(e^{-b_n r}/r)$, where $N_n(r)$ and $I_n(r)$ respectively are the fractions of photons and energies emerging perpendicularly at a point r. Monte Carlo calculations by collision density method were performed to confirm the validity of the above relations, as well as to verify that the radial distribution of photons backscattered in all directions from the slab surface is subject to the same relations as above. The values of the constants $a_n$ and $b_n$ obtained by experiment were rather smaller than those by calculation, but the values of the constants for the radial distribution of photons backscattered in all directions were nearly equal to those for the normal direction. The relation between the values of the constants and the number and energy albedos was examined. (auth)

**29174** TRITIUM MONITOR (Engineering Materials). (du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). (CAPE-1871).
6 drawings.

A portable monitor is described which accurately measures tritium concentrations between $1 \times 10^{-4}$ and $1 \times 10^{-1}$ $\mu$Ci/cc of of air. The instrument consists of an air pump, detonizer, ionization chamber, logarithmic electrometer-amplifier and a high voltage power supply. An internal rechargeable 12-V battery powers the monitor. A connector is provided so that an external 12-V battery can be used if the monitor is needed for extended periods of time. After calibration by comparison with a Kanne monitoring system under varying levels of tritium activity, readings were reproducible within ±10%. (For details see TID-4100 Suppl. 53) (See also NSA 23: 16084). (F.S.)

**29175** MEASUREMENTS OF HIGH THERMAL NEUTRON FLUXES BY ACTIVATION DETECTORS. Biryukov, E. I.; Novikov, V. T.; Khramov, N. N.; Shimanskaya, N. S.; Yakovlev, R. M. At. Energ. (USSR), 26: 332-4(Apr. 1969). (In Russian).

A detector is described for measurements of high neutron fluxes which has the following advantages: it does not distort neutron fields and it permits activity measurements to be taken immediately after irradiation. With gold and cobalt detectors the thermal neutron flux density in two channels of the VVRM reactor was measured. The gold and cobalt detector thermal neutron flux measurement data correlate well in a range of 2–5%. The suggested detectors may be used for measuring effective thermal neutron fluxes in reactionally active media. (auth)

**29176** USE OF THE ASSOCIATED PARTICLES METHOD FOR DETERMINING THE DETECTION EFFICIENCY OF THE $D(d,n)^3He$ NEUTRONS. Greil, A.; Truetzschler, K. (Institut fuer Experimentelle Kernphysik, Dresden). Kernenergie, 12: 68-70(Feb. 1969). (In German).

The features of using the method of associated particles with respect to the $D(d,n)^3He$ reaction are described. A surface-barrier detector was employed as the $^3He$ detector, a plastic scintillator photomultiplier of K14FS50 type as the neutron detector. The arrangement makes possible the absolute determination of the detector efficiency for 2.5 MeV neutrons. (auth)

**29177** FAST ELECTRONICS FOR A SCINTILLATION COUNTER TELESCOPE. Manuzio, G.; Racca, L.; Grianti, F. (Istituto Nazionale di Fisica Nucleare, Genoa. Univ., Genoa). Nucl. Instrum. Methods, 71: 77-85(1969).

The electronics of a scintillation counter telescope used to record, against a high electron background, photoproton spectra from low-z nuclei irradiated with bremsstrahlung γ-beams were described. (auth)

**29178** SHORTENING OF DETECTOR SIGNALS WITH PASSIVE FILTERS FOR PILE UP REDUCTION. Amsel, G.; Bosshard, R.; Zajde, C. (Ecole Normale Superieure, Orsay, France). Nucl. Instrum. Methods, 71: 1-12(1969).

It is shown that the duration of detector signals does not set the ultimate limit to acceptable counting rates in linear systems. Unipolar signals shorter than the physical phenomenon taking place in the detector may be obtained by inserting a two-port, the transfer function of which approximates the inverse of the transfer function equivalent to the detector output. A system so compensated is termed detector matched. Iterative passive filters of bridged T type, most easy to construct, yielding a constant resistive impedance (50 Ω – 50 Ω for instance), may be inserted anywhere in the system. Results are shown for various devices: semiconductor detectors and scintillators like plastics, anthracene and NaI(Tl). For fast scintillators the width of the signal may be reduced to nearly that of the photomultiplier SER. The effect on energy resolution is discussed. (auth)

**29179** ION IMPLANTED GERMANIUM PARTICLE DETECTORS. Dearnaley, G.; Hardacre, A. G.; Rogers, B. D. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 71: 86-92(1969).

Thin-windowed germanium detectors have been prepared by ion implantation with gallium followed by a conventional lithium ion-drift. Such a detector has shown an overall energy resolution of 37 keV (fwhm) for 34 MeV protons. Of this total linewidth, the contribution due to the detection system alone is estimated to be 22 keV. A description is given of a cryostat assembly which allows dE/dx and E particle discrimination by means of a silicon and germanium detector telescope. Other applications of thin-windowed germanium detectors are also considered. (auth)

**29180** A METHOD FOR CORRECTING CLINICAL RECORDING IN LABELED-INDICATOR TECHNIQUES. Benetazzo, L. C.; Leskovic, G. L. (Univ., Padua). Dig. Int. Conf. Med. Biol. Eng., 7th, Stockholm, 1967, 171(1967).

From 7th International Conference on Medical and Biological Engineering, Stockholm, Sweden. See CONF-670808.

A procedure to correct the recording accuracy of clinical radioisotope measurements is presented. It is assumed that the instrument is characterized by a nonunitary transfer function G(s), with x(t) the correct signal and y(t) the plotted one. The results of the correction were highly satisfactory, with a transfer function of $G_0(s) = 1/(1 + s\tau)$, where the rate meter time constant was $\tau$ and the corrected curve was $x(t) = y + \tau dy(t)/dt$. The method was suitable for the cardiac output dilution curve tested. (BBB)

**29181** LARGE AREA LIQUID SCINTILLATION WHOLE-BODY COUNTERS FOR ROUTINE CLINICAL USE. Barnaby, C. F.; Jasani, B. M.; Smith, T. (University Coll., London). Dig. Int. Conf. Med. Biol. Eng., 7th, Stockholm, 1967, 172(1967).

From 7th International Conference on Medical and Biological Engineering, Stockholm, Sweden. See CONF-670808.

Whole-body counters, particularly suitable for routine clinical applications, are described. One counter has rectangular Perspex tanks, each with dimensions of about 2 × 1 × 0.3 m viewed by two 12-in. photomultipliers at each end, arranged one above the other with the patient or other source placed between them. A counter 24 × 16 × 4 in. having two 5-in. photomultipliers placed at one end and with a mirror at the opposite end was sufficiently sensitive for many clinical applications. Both counters were shielded by a 16-in. thickness of chalk, packed around the counter to a density of 1.5 g/ml. The smaller counter could detect 10 mμCi of an isotope which emits one 1.5-MeV γ ray/disintegration to a standard error of counting statistics of 3% in a counting time of 1000 sec. This amount of radioactivity is equivalent to the $^{40}K$ content of the standard man. The large counter described is able, with similar shielding, to detect 10 mμCi to within 2% in a counting time of about 200 sec. An excellent scintillator mixture consisted of 30% distilled Shellsol A in medicinal kerosene in which was dissolved 1.4 $gl^{-1}$ p-terphenyl, 0.014 $gl^{-1}$ POPOP and 1.0 $gl^{-1}$ PPO. The cost was low, the efficiency was comparable to the best liquid scintillator and better than plastic scintillator. The chemical activity was very low, the transparency was sufficiently high for use in a counter 2-m long, and the fire hazards and toxicity associated with its use were negligible. The attenuation coefficient for the liquid recommended for 1.5-MeV γ rays was ~0.05 $cm^2/g$ and thicknesses of 4 and 12 in. gave 45 and 85% interactions, respectively. The shielded background of the counters above 0.5 MeV was about 8 counts/sec/l of scintillator; the resolutions obtained from the counters were sufficiently good for the vast majority of clinical applications. (BBB)

**29182** AN ADVANCED FLAT-FIELD UPTAKE DETECTOR. Williams, J. B. (Miles Labs, Inc., Billerica, Mass); Hine, G. J.; Burnham, C. A. Dig. Int. Conf. Med. Biol. Eng., 7th, Stockholm, 1967, 173(1967).

From 7th International Conference on Medical and Biological Engineering, Stockholm, Sweden. See CONF-670808.

The detector system is described which provides an increase in sensitivity of measurement of thyroid uptake of $^{131}I$ by a factor of more than 10 while essentially eliminating many errors. The uncertainty in thyroid location due to the source-detector distance leads to errors because of the uncertainties in the size, shape, and location of the thyroid gland as well as in the amount of adjacent absorbing and scattering tissues. The detector design incorporates two 1 × 3 in. scintillation crystals. The sensitive volume consists of the combined sensitivity in the region of intersecting fields with a fall-off faster than inverse-square beyond. The use of sharp collimation in front of the crystals generates a response within the sensitive volume which increases faster than inverse-square as the source-detector distance is increased. This characteristic is adjusted to compensate for the effect of added self-absorption when the thyroid is over-laid with tissue. The system sensitivity of 8000 cpm/μCi ensures that fast, accurate determinations can be made with a delivered dose of 1 Rem or less. The relative independence of thyroid location within the 3-dimensional flat field is shown. The use of 1-mm-thick Pb absorbers in front of the crystals eliminates all scattered quanta, allowing the discrimination level to be set at about 25 keV for maximum detection efficiency and plateau operating point stability. This system was found to be accurate to better than 2% for all conditions of uptake measurements. (BBB)

**29183** MICROMINIATURIZED DETECTORS FOR IN-VIVO RADIOISOTOPE UPTAKE STUDIES AND FOR THE RAPID DETECTION OF TUMOR HORMONE DEPENDENCE. Youdin, M. (Mount Sinai Hospital, New York); Anton, N. G.; White, R. L.; Herter, F. P. Dig. Int. Conf. Med. Biol. Eng., 7th, Stockholm, 1967, 175(1967).

From 7th International Conference on Medical and Biological Engineering, Stockholm, Sweden. See CONF-670808.

The method of embedding isotope monitors in tumors, to follow the levels of $^{32}P$ incorporated in tumors to predict the long-term effect on the tumor growth of all types of nonoperative tumor treatment, is described. The usefulness of this method to evaluate nonoperative forms of cancer treatment in humans was tested in superficial tumors of patients with inoperable carcinoma. Continuous uptake records were obtained for 152 hr with a single intravenous injection of from 308 to 500 μCi of $^{32}PO_4$. In five patients, three with breast carcinomas, there was no growth response to hormone or chemotherapy in a 4- to 7-month follow-up. All showed a characteristic pattern of $^{32}P$ incorporation in a tumor consisting of a rapidly attained "vascular" peak, a subsequent loss of $^{32}P$, and a third phase of prolonged conservation of $^{32}P$. Three tumors with hormonal or chemotherapy lost 22 to 96% of their mass over a 2.5 to 9 month follow-up. Evenly spaced rises and falls of $^{32}P$ content were seen. These tumors also demonstrated a marked increase in the rate of third phase $^{32}P$ loss after initiation of hormonal therapy. The $^{32}P$ loss rates varied from 170.1 to 410.0%, corrected for $^{32}P$ decay. (BBB)

**29184** INSTRUMENTATION FOR TRACER TRANSIT TIME MEASUREMENTS IN CORTEX AND MEDULLA OF CANINE KIDNEY. Glaser, E. M.; Pinter, G. G. (Univ. of Maryland, Baltimore). Dig. Int. Conf. Med. Biol. Eng., 7th, Stockholm, 1967, 175(1967).

From 7th International Conference on Medical and Biological Engineering, Stockholm, Sweden. See CONF-670808.

A technique that uses a solid state β-ray detector to detect $^{32}P$ and $^{131}I$ in renal tissue is described. The mean transit times for $^{131}I$-labeled albumin in the cortex and medulla were calculated to be 5 and 20 sec, respectively. Cortical transit time measured was longer than previous values, while there are reasonably good agreement between medullary transit times. Experiments to determine mean transit times of various labeled compounds in the renal cortex and medulla under different experimental conditions were outlined. (BBB)

**29185** MOSFET RADIATION DOSE POCKET ALARM MONITOR. Keller, J.; Bukowiecki, B. (Central Lab. for Radiation Protection, Warsaw). Dig. Int. Conf. Med. Biol. Eng., 7th, Stockholm, 1967, 487(1967).

From 7th International Conference on Medical and Biological Engineering, Stockholm, Sweden. See CONF-670808.

Monitors that sound an alarm after a predetermined level of rate or dose has been exceeded, and that are small enough to be carried about in the pocket, are described. The dose alarm monitor consists of two parts, making up a flat prism 11 × 7 × 2.5 cm. One part forms the ionization chamber of 6 pF capacity, shaped for low saturation voltage: 90% at 3 V. The second part contains the electronic system. The mode of operation is described. The dose alarm is proportional to the tank capacity, which in the present monitor, corresponds to 300 mR. The accuracy and the minimum measurable dose are limited by the blocked MOSFET gate current and the leakage of the chamber and the capacitor. In the ambient temperature range from 1 to 40°C, the dose does not change, provided the exposure starts when the monitor switches on; in case of 5 hr delay the dose drops by less than 5%. (BBB)

**29186** A NEW TECHNIQUE FOR CAPTURE AND FISSION CROSS SECTION MEASUREMENTS. Czirr, J. B. (Univ. of California, Livermore). Nucl. Instrum. Methods, 72: 23-8 (1969).

A technique is described for obtaining, simultaneously, capture and fission cross sections with the same detector—a deuterated-benzene-based liquid scintillator. Neutron and γ-ray events are separated by pulse-shape discrimination, and on-line pulse-height weighting is used to ensure spectral independence for capture events. With the present technique, the latter requirement is satisfied for detector arrays of large solid angle. (auth)

**29187** DEVELOPMENTS IN LIQUID SCINTILLATION COUNTING SINCE 1963. Parmentier, J. H. (Central Lab. TNO, Delft, Netherlands); Ten Haaf, F. E. L. Int. J. Appl. Radiat. Isotop., 20: 305-34(May 1969).

The literature on developments in liquid scintillation counting since 1963 is reviewed, and developments in the instrumentation of commonly used, commercially available instruments are described, together with methods for the determination of quench corrections. Sample preparation techniques, especially for biological and biochemical applications, are extensively reviewed. References are given for topics such as absolute counting methods and the measurement of beta activities using Cherenkov photons. (auth) (UK)

**29188** X-RAY EXPERIMENT ELECTRONIC INSTRUMENTATION FOR HIGH ALTITUDE BALLOON AND ROCKET FLIGHTS. Cancro, C. A.; Crockett, W. R.; Garrahan, N. M.; McGowan, R. G. (Goddard Space Flight Center, Greenbelt, Md.). Nucl. Instrum. Methods, 72: 13-22(1969).

An electronic instrumentation system, developed for use in x-ray experiments to be flown on high-altitude balloons and rockets, is described. The system selects and analyzes output pulses from x-ray detector proportional counters and scintillating crystals, arranges the desired data in a PCM format and feeds this digital data at a 50 to 100 kHz bit rate to the telemetry transmitter. The system is designed to minimize power drain, weight and volume, while maintaining a high degree of reliability. The system has operated successfully in a 1968 rocket flight. Additional rocket and balloon flights, making use of variations of this system, are planned for the near future. (auth)

**29189** PLASMA TIME AND RELATED DELAY EFFECTS IN SOLID STATE DETECTORS. Alberigi Quaranta, A. (Univ., Modena, Bologna); Taroni, A.; Zanarini, G. Nucl. Instrum. Methods, 72: 72-6(1969).

The initial delay in the response of surface barrier detectors to heavily ionizing particles is experimentally studied. Various experimental results are given about this delay in different detectors as a function of electric field and temperature. These results can be of particular interest in experiments requiring a time reference obtained by means of a solid state detector. (auth)

**29190** RAPID DETERMINATION OF RADIONUCLIDE ACTIVITIES BY A WELL-TYPE GAMMA-IONIZATION CHAMBER. Bensch, F.; Ledermann, H. (Oesterreichische Hochschule, Vienna). Nucl. Instrum. Methods, 72: 56-60(1969).

A well-type ionization chamber has been carefully calibrated for 13 radionuclides. The interpretation of the results leads to simple relations enabling users to standardize samples of arbitrary γ-active nuclides of activities between 100 μCi and 1 Ci and with γ-energies between 100 keV and 2 MeV. The absolute activity can be determined with an accuracy sufficient for most applications, e.g., for the measurement of activities in ampoules. (auth)

**29191** METHOD TO CORRECT FOR CHARGED-PARTICLE SIGNAL LOSS IN LITHIUM-DRIFTED DETECTORS. Frederick, D. E. (Ames Lab., Iowa). Nucl. Instrum. Methods, 72: 35-9(1969).

In semiconductor detectors, the charge collection time will vary with the physical point of deposition of energy within the intrinsic region of the detector. This leads to a geometrical dependence of the signal risetime so that if the signal risetime is not negligible relative to the amplifier differentiation time constant, varying signal loss will occur. For charged-particle spectroscopy this loss will vary with incident particle kinetic energy. An energy-scale correction method is described for charged-particle spectroscopy in detectors of the p-i-n type. This method reduces energy scale distortions by about a factor of ten. (auth)

**29192** STUDY OF NOISE IN LOW-ENERGY, LOW-INTENSITY BETA ACTIVITY MEASUREMENTS. Breyer, B. (Rudjer Boskovic Inst., Zagreb). Nucl. Instrum. Methods, 72: 103-6(1969).

The problem of using low noise preamplifiers and amplifiers in integral beta activity measurements is considered. An attempt has been made to set the limits of this class of measurements with respect to electrical noise. The lowest sample-to-background counting rate ratio is discussed, taking into account the contribution of electronic noise to the total counting rate. It has been shown that a pulse shaping network should be applied in order to achieve an optimal signal-to-noise ratio. In the case of linear RC filters, single differentiation and at least double RC integration should be used. (auth)

**29193** FLEXIBLE DETECTOR CRYOSTAT. Franke, H. F. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods, 72: 107-8 (1969).

A cryostat for nonencapsulated Ge(Li) semiconductor radiation detectors is described. The connection between cryostat and liquid nitrogen reservoir is flexible, so that the cryostat can be used in all positions between vertical and horizontal (right angle). (auth)

**29194** CALCULATION OF EFFICIENCY AND CROSS SECTION OF CYLINDRICAL SCINTILLATORS IN AXISYMMETRICAL GAMMA-RAY FIELDS. Schaarschmidt, A.; Keller, H.-J. (Johann-Wolfgang-Goethe-Univ., Frankfurt am Main). Nucl. Instrum. Methods, 72: 82-92(1969).

A method is described for the accurate numerical calculation of efficiency and cross section (i.e., the ratio of the rate of detected quanta to the nondirectional flux) of cylindrical scintillators in axisymmetrical γ-ray fields. Sample results are presented for 3″ × 3″ and 5″ × 5″ NaI scintillators for the following angular distributions of the radiation: isotropic radiation (100 keV–100 MeV); extended parallel beams at angles of 0, 22.5, 45, 67.5 and 90° to the axis of the scintillator, results plotted vs μR; and a field of multiply scattered γ-rays in an extended scattering medium with initial Energy $E_0$ = 1 MeV, approximated by (a) Gaussian angular distribution, broadening with decreasing energy, (b) angular distributions given by Berger, and (c) by Stehfest. The direction of symmetry of these radiation fields is taken parallel to the axis of the scintillator. The approaches to efficiency and cross section used hitherto for multiply scattered γ-radiation are briefly discussed. The exact results presented here differ remarkably from these simple approximations. (auth)

**29195** EXPERIMENTAL DETERMINATION OF THE EFFICIENCY OF THE GREY NEUTRON DETECTOR. Poenitz, W. P. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 72: 120-2(1969).

The energy dependence of the efficiency of the grey neutron detector was measured in the energy range 30 to 1400 keV by means of the associated activity technique and the flux integration technique. A maximum deviation of 3.5% from the theoretical calculated efficiency curve was found. The detector was used to measure the energy dependence of the $^7$Li(p,n) cross section. (auth)

**29196** PION ENERGY MEASUREMENT USING ΔE DETECTORS. Sobottka, S. E.; Ferguson, C. R. (Univ. of Virginia, Charlottesville). Nucl. Instrum. Methods, 72: 123-4(1969).

The fractional resolution in the energy of low-energy pions as measured with silicon ΔE detectors is calculated and shown to be good enough for certain scattering experiments. (auth)

**29197** ELECTRONIC ELIMINATION OF NOISE PULSES IN SCINTILLATION COUNTING. Siegenthaler, R. (Univ. of Bern). Nucl. Instrum. Methods, 71: 173-86(1969).

The principle of operation and the performances of a circuit designed for electronic elimination of noise pulses in a scintillation spectrometer are described. The circuit makes use of the fact that the photoelectrons which are released at the cathode of the photomultiplier due to a single scintillation flash are not exactly coincident in time, since the respective photons are emitted according to the transient decay characteristics of the involved scintillator. Because more than one noise pulse (single electron

pulse) within the decay time $\tau$ is highly improbable to occur, the pulses consisting of two or more photoelectrons within $\tau$, are signal pulses originating from a scintillation flash. These pulses are accepted, whereas noise pulses are discriminated by means of the fast photomultiplier able to resolve a signal pulse into its sequential single electron pulses and by means of a difference amplifier which compares the amplitudes of an integrated dynode output and a differentiated anode output of the photomultiplier. The limits of this elimination principle and the resulting design features are discussed. The spectrometer presented makes use of the high speed RCA C 70045 D photomultiplier. Both slow and fast scintillators can be used. The elimination circuit decreases the noise count rate to about 5% of its original value. The experimental results are illustrated with pulse height spectra obtained with various scintillators and radioactive sources. The measurements show that a further decrease of the residual noise count rate to less than 0.1% of its original value can be achieved if the arrangement is to operate with fast scintillators only. (auth)

**29198** GAMMA RAY IMAGE CHARACTERISTICS IN SODIUM IODIDE SLABS. Knoll, G. F. (Univ. of Michigan, Ann Arbor). Nucl. Instrum. Methods, 71: 163-9(1969).

A Monte Carlo calculation has been made of the effects of detector scattering on the gamma ray imaging properties of sodium iodide slabs. All interactions within the detector were assumed to contribute to the image. A detailed accounting was kept of the radial distribution away from the point of incidence of both the number of interactions and the deposited energy. Data are presented for slabs of thickness ranging from $\frac{1}{8}$" to 2" and over the energy interval from 140 to 999 keV. (auth)

**29199** NEW LARGE-ACCEPTANCE AND HIGH-EFFICIENCY NEUTRON DETECTOR FOR MISSING-MASS STUDIES. Bollini, D.; Buhler-Broglin, A.; Dalpiaz, P.; Massam, T.; Navach, F.; Navarria, F. L.; Schneegans, M. A.; Zetti, F.; Zichichi, A. (CERN, Geneva. Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna. Centre de Recherches Nucleaires, Strasbourg). Nuovo Cim., 61A: 125-72(May 21, 1969).

A large-acceptance and high-efficiency neutron detector is described. The sensitive surface and volume of the detector are 2.16 $m^2$ and 0.78 $m^3$, respectively. The detector consists of twenty-four elements of plastic scintillator, each having dimensions (100 × 18 × 18) $cm^3$. The large volume of scintillator, in the particular geometrical arrangement chosen, allows a mean detection efficiency of about 25% in the range (70 + 390) MeV neutron kinetic energy for a laboratory solid angle of 0.14 sr at 4 m radial distance. With the techniques adopted, calibrations with charged particles can be easily performed in a few hours using a low beam intensity. An interesting feature of this instrument is the accuracy achieved in locating incident particles, which is ±1.4 cm for charged particles, and ±2.5 cm for neutrons. The accuracies achieved for the time-of-flight measurement are ±0.35 ns for charged particles and ±0.7 ns for neutrons. With these resolutions in the neutron time of flight and angle, the uncertainty in the missing mass is ±4 MeV for $\eta$, ±10 MeV for $\omega$, and ±15 MeV for $\omega$ mesons. (auth)

**29200** ON-LINE COMPUTER METHOD OF PARTICLE IDENTIFICATION. Hird, B. (Univ. of Ottawa); Ollerhead, R. W. Nucl. Instrum. Methods, 71: 231-3(1969).

A particle identification method, in which an experimental range-energy relation is stored in the computer memory, is relatively fast and potentially more selective than analog devices. (auth)

**29201** CALCULATION OF THE SPECTRAL DISTRIBUTION OF SECONDARY RADIATION IN HOMOGENOUS PHANTOM ON NUMERICAL COMPUTER. Chernitsova, T. P. (Lab. of Medical Sources for Ionization Radiation and Clinical Dosimetry, Moscow). Med. Radiol., 14: No. 5, 53-7(May 1969). (In Russian).

The problem of spectral distribution of secondary gamma-radiation at any site lying on the axis of the irradiated homogeneous tissue-equivalent cylinder is considered. For single and two-stage scattering analytical formulas were obtained. The task of multiple scattering ($n \geq 3$) is solved by the Monte-Carlo technique. (auth)

**29202** RESPONSE IN THE RADIATION MEASURING SYSTEM HAVING A RC INTEGRATING CIRCUIT. Nojiri, Toshiaki (Industrial Research Inst., Yokohama, Japan). Kanagawa-ken Kogyo Shikenjo Kenkyu Hokoku, No. 22, 55-8(Sept. 1968). (In Japanese).

When measuring the rapidly changing radiation-intensity with a count-rate meter, the response is observed by the time constant. The effect on the output of the instant-input change is known by the time constant, but in the complex fluctuation, the response function is employed. The response function being a sinusoidal wave response, the input fluctuation is made to the sinusoidal wave-shape by Fourier transformation, to derive the output fluctuation. The following are described: the RC integrating circuit and the transfer function; the output when shaped pulses are put into the RC integrating circuit; analysis of the pulse counts with the intensity changing sinusoidally; the response of the count-rate meter; and errors. (NSA of Japan)

**29203** A PROPORTIONAL COUNTER FOR LOW-LEVEL MEASUREMENT OF $^{239}$Pu IN LUNGS. Taylor, B. T. (Atomic Energy Research Establishment, Harwell, Eng.). Health Phys., 17: 59-69(July 1969).

A large area proportional counter designed for the determination of $^{239}$Pu in human lungs at low levels is described. The counter uses the multiwire method of internal anticoincidence for background reduction. The technique of pulse rise-time discrimination in favor of low energy x-rays was applied. The background of the counter (window area 900 $cm^2$) is 2.2 counts/min in the energy band from 10 to 24 keV used for $^{239}$Pu determinations. The counter was calibrated at 20 keV using seven volunteer subjects who inhaled aerosols labelled with 17 day $^{103}$Pd. The derived minimum detectable activity for a subject of average build was 8 nCi of $^{239}$Pu, i.e., about half the maximum permissible lung burden. (auth) (UK)

**29204** BACKGROUND REDUCTION IN THE ENERGY REGION 10 TO 25 keV. Dean, P. N. (Los Alamos Scientific Lab., N. Mex.). Health Phys., 17: 157(July 1969).

Thin NaI(Tl) and CsI(Tl) crystals are commonly in use for the in vivo measurement of $^{238}$Pu and $^{239}$Pu in the lung. Americium-241 is usually used as a tracer for plutonium, and the measurement is made at 60 keV. The background is generally too high at the x-ray energy of 17 keV to make measurements at this energy feasible. The use of pulse-shape discrimination techniques is described in an effort to reduce the background at 17 keV. By gating the multichannel analyzer to accept only those pulses with a rise time corresponding to the decay time of the pulse from NaI(Tl), it is possible to count only true x-ray events in the crystal. (auth) (UK)

## *Nuclear Spectroscopic Instrumentation*

*Refer also to abstracts 29260 and 30853.*

**29205** (AD-683323) COMPTON-SUPPRESSED COINCIDENCE GAMMA-RAY SCINTILLATION SPECTROMETER WITH LARGE NaI(Tl) CRYSTALS. Euler, Bruce A.; Covell, David F.; Yamamoto, Sachio (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 19, 1968. 55p. (USNRDL-TR-68-150). CFSTI.

A Compton-suppressed coincidence gamma-ray scintillation spectrometer has been assembled to obtain high sensitivity and selectivity in gamma-ray spectral measurements. The spectrometer is intended to satisfy requirements for the identification and estimation of low levels of gamma-ray radioactivity in a broad range of sample sizes and masses containing moderately complex mixtures of gamma-emitting radionuclides. (auth) (USGRDR)

**29206** (ANL-7517) WIDE-BAND CHARGE-SENSITIVE PREAMPLIFIER FOR PROTON-RECOIL PROPORTIONAL COUNTING. Larson, J. M. (Argonne National Lab., Ill.). Feb. 1969. Contract W-31-109-eng-38. 18p. Dep. CFSTI.

This report describes a solid-state charge-sensitive preamplifier for use with proportional counters in proton-recoil spectrometers. The preamplifier has a charge gain of $2 \times 10^{12}$ V/coulomb and exhibits a rise time of 15 nsec, without overshoot, with 10 pF of external input capacity. A high-transconductance field-effect transistor is used in the input stage and near theoretical noise performance is obtained. The circuit is direct-coupled and is compatible with pole-zero compensated amplifier systems. The preamplifier features a 20-V peak output swing to allow high count-rate capability and the amplification of extreme overloads without saturation. (auth)

**29207** (N-69-19828) LITHIUM-DRIFTED SILICON DETECTORS AS LOW-ENERGY PHOTON SPECTROMETERS. Beck, Sherwin M. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Mar. 1969. 23p. (NASA-TN-D-5056). CFSTI.

Lithium-drifted silicon detectors were fabricated from 10,000 ohm-centimeter, p-type silicon and were tested for use as low-energy photon spectrometers. Three x-ray and gamma ray sources ($^{241}$Am, $^{57}$Co, $^{109}$Cd) were used to determine the energy resolution. At 77°K and less than $10^5$ torr (1.33 mN/$m^2$) the detector resolution varied from 0.82 keV (full width half maximum (fwhm)) at a photon energy of 22.10 keV to 1.04 keV (fwhm) at 122.05 keV with detector amplifier noise (measured with a pulse generator) almost

constant at 0.75 keV (fwhm). From these measurements an intrinsic detector resolution corresponding to a Fano factor of 0.205 was calculated. (auth) (STAR)

**29208** APPLICATION OF THE TRIPLE GRID LEED SYSTEM TO AUGER SPECTRUM ANALYSES. Morrison, J.; Lander, J. J. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Vac. Sci. Technol., 6: 338-40(Mar.-Apr. 1969).

Equipment and procedures for analyzing surface structures based on Auger spectrum analysis methods using a triple grid low energy electron diffraction (LEED) system are described. (W.H.K.)

**29209** COMBINATION OF ON-LINE ANALYSIS WITH COLLECTION OF MULTICOMPONENT SPECTRA IN AN ON-LINE COMPUTER. Wilburn, N. P.; Coffin, L. D. (Battelle Northwest, Richland, Wash.). IBM J. Res. Develop., 13: 46-51(Jan. 1969).

A digital computer has been interfaced to four 256-channel analyzers. All functions of normal multichannel analyzers have been reproduced by suitable coding. In addition, a weighted least-squares method for estimating on line the contribution of individual radionuclides in a multicomponent pulse height spectrum has been incorporated. Details of the mathematics and coding methods, which include special modifications to an existing FORTRAN system for on-line use, are described. (auth)

**29210** AN EFFICIENCY-INDEPENDENT METHOD IN $\gamma$ RAY SPECTROMETRY. Adam, G.; Katriel, J. (Nuclear Research Center, Negev, Israel). Health Phys., 16: 795-6(June 1969).

One of the difficulties encountered in the absolute calibration of $\gamma$ sources is the accurate determination of the detector's efficiency and its energy dependence. A method is proposed by which determination of absolute activity can be obtained independent of the efficiency, provided the source emits at least two $\gamma$ photons in cascade. In a simple $N > 2$ photon $\gamma$ cascade the peaks observed are the N photopeaks and all the sumpeaks originating from combinations of two, three, etc., photons (assuming for simplicity that no two peaks have the same energy). (auth) (UK)

**29211** MAGNETIC BETA SPECTROMETER SYSTEM FOR AUTOMATIC MEASUREMENT OF INTERNAL CONVERSION ELECTRON SPECTRA. Vinogradov, V. I.; Kadashevich, V. I. Izmer. Tekh., No. 3, 79-80(Mar. 1969). (In Russian).

Special spectrometric apparatus for studying conversion electron spectra in $(n,\gamma)$ reactions is described. A block diagram of the system for automatic measurement of the spectra and data processing is given. (tr-auth)

**29212** SPECTROMETER FOR PHOTOPROTONS. Baglin, J. E. E.; Thompson, M. N. (Yale Univ., New Haven). Nucl. Instrum. Methods, 71: 71-6(1969).

A photoproton spectrometer suitable for use with high intensity electron accelerators is described. Its construction, shielding and associated electronics are discussed. Typical spectra are shown. (auth)

**29213** SMALL SPLIT NaI(Tl) ANNULUS-Ge(Li) SPECTROMETER FOR COINCIDENCE-ANTICOINCIDENCE WITH IN-BEAM GAMMAS. Draper, J. E.; Smith, G. L. (Univ. of California, Davis). Nucl. Instrum. Methods, 70: 134-40(1969).

A small gamma-ray spectroscopy system useful for in-beam spectroscopy is described. The system consists of a small Ge(Li) central detector surrounded by a 12.7 cm o.d. by 2.5 cm i.d. by 14.0 cm long NaI(Tl) annulus split into quadrants. The system can be operated as an anti-Compton spectrometer, in which case the Compton continuum is reduced by a factor of 3 to 6. Approximate calculations of the expected Compton reduction factor were made and the results compared to experiment. In addition, the system can be used as a three-crystal pair spectrometer. Results are presented. (auth)

**29214** INFLUENCE OF HYSTERESIS ON SHAPE FACTOR MEASUREMENTS WITH A DOUBLE FOCUSING IRON BETA SPECTROMETER. Booij, H. M. W.; Van Hoek, E. A.; Blok, J. (Vrije Univ., Amsterdam). Nucl. Instrum. Methods, 72: 40-4(1969).

The reliability of a double focusing iron beta spectrometer for the measurement of the shape of beta spectra has been investigated. The method used to estimate the influence of a change in the magnetic state of the iron on the transmission is described. The results of this method applied to a spectrometer together with the experiments to test these results are given. (auth)

**29215** INVESTIGATION OF THE SPECIFIC ENERGY LOSS OF PROTONS IN HYDROGEN ABOVE 1 keV WITH REGARD TO NEUTRON SPECTROMETRY. Werle, H.; Fieg, G.; Seufert, H.; Stegemann, D. (Kernforschungszentrum Karlsruhe, Ger.). Nucl. Instrum. Methods, 72: 111-19(1969).

The variation of ionization, created in hydrogen filled proton-recoil proportional counters by protons with energies between 1 and 20 keV was measured, using quasi-monoenergetic neutrons from a slowing-down time spectrometer. The measured variation can be described by $E = I - 0.15 + \exp(-I/1.76)$, where E means the neutron energy (in keV) and I the ionization (in keV). The results are in satisfactory agreement with results of work described in literature and should contribute to improve the accuracy and reliability of proton-recoil neutron spectrometry in the low energy range. (auth)

**29216** FAST NEUTRON TIME-OF-FLIGHT SPECTROMETER WITH NEUTRON-GAMMA RAY DISCRIMINATION. Wakuta, Y.; Tawara, H.; Hyakutake, M.; Sonoda, M. (Kyushu Univ., Fukuoka). Nucl. Instrum. Methods, 71: 133-6(1969).

A fast neutron time-of-flight spectrometer with neutron-gamma ray discrimination based on the method developed by Alexander et al. is described. A combination of a 5" dia NE213 liquid scintillator and a 5" dia XP1040 photomultiplier is used both for neutron-gamma discrimination and neutron energy measurements. This spectrometer has a time resolution less than 2.0 nsec and is used at a counting rate as high as $4 \times 10^4$ pps. (auth)

**29217** SPECTRUM DISTORTION FROM AMPLIFIER OVERLOADS IN PROTON-RECOIL PROPORTIONAL COUNTING. Larson, J. M.; Powell, J. E. (Argonne National Lab., Idaho Falls, Idaho). Nucl. Instrum. Methods, 71: 157-62(1969).

The problem of spectrum distortion from amplifier overloads in proton-recoil proportional counting has been studied. These studies show that the distortion is caused by amplifier paralysis which results from severe overloading of the ionization amplifiers. An amplifier system is reported that uses pole-zero compensation techniques and active baseline restoring to extend the overload tolerance of the ionization amplifiers, thereby greatly increasing the count rate capability of the spectrometer. The compensated system is tested by measuring proton spectra at various counting rates in a plutonium fueled fast reactor (ZPR-3). Spectra taken with the compensated amplifier system and with a conventional double differentiated system are compared. An approximate three times improvement in overload capabilities is obtained with the compensated system. (auth)

**29218** LIGHT TRANSIT-TIME COMPENSATOR FOR LARGE SCINTILLATORS. Guyon, J.; Pigneret, J.; Gouanere, M. (Univ., Lyon). Nucl. Instrum. Methods, 71: 215-17(1969).

An electronic system has been constructed to minimize the timing incertitude due to the transit time of the light emitted in large plastic scintillators (7 $dm^3$). The system needs no adjustment and gives at its output a timing pulse which shifts by no more than ±120 ps for different points of interaction of the incident particle in the scintillator crystal. The time resolution obtained with 400 keV collimated gamma rays is 1.1 ns (fwhm). (auth)

## *High Energy Physics Instrumentation*

*Refer also to abstract 29201.*

**29219** (IFA-PN-21) USE OF A PULSED ELECTRIC FIELD FOR THE DISCRIMINATION OF IONIZING PARTICLES RECORDED IN A NUCLEAR EMULSION. Labau, V. (Academia R. P. R., Bucharest, Institutul de Fizica Atomica). 1968. 10p. (In French). Dep.

The use of a pulsed electric field for discriminating ionizing particles recorded in a nuclear emulsion is described for the study of nuclear reactions with certain light elements such as lithium and boron bombarded by thermal neutrons. (J.F.P.)

**29220** (NP-tr-1785) ON THE OPTICAL ANISOTROPY OF THE SAFETY GLASS IN THE 5-METRE HYDROGEN BUBBLE CHAMBER. Zapletal, A. (Joint Inst. for Nuclear Research, Dubna (USSR). [Lab. of High Energy]). Translated by J. E. Baker (Atomic Energy Research Establishment, Harwell, Eng.), from report JINR-P13-4059. 31p. Dep. CFSTI.

The stress condition of some safety glasses is determined. These glasses partition the photographic devices from the hydrogen, which is under pressure, in a hydrogen bubble chamber. This stress condition, from the pressure of the hydrogen and the seal, causes distortion of the image of the particle trajectories being photographed. To determine the extent of the distortion the stress condition of the glasses is studied. (J.F.P.)

**29221** (SLAC-99) CIRCE: A GENERAL MULTI-PRONG FITTING COMPUTER PROGRAM FOR SPATIAL COORDINATES IN A NON-UNIFORM MAGNETIC FIELD. Fries, Dietrich E. (Stanford Linear Accelerator Center, Calif.). Mar. 1969. Contract AT(04-3)-515. 30p. Dep. CFSTI.

The computer program CIRCE, developed to perform a non-linear least square fit for optimization of particle trajectories in a non-uniform magnetic field in bubble and spark chambers, is described. (W.H.K.)

**29222** (SLAC-PUB-593) SLAC SPIRAL READER SYSTEM. Hu, Michael J. C. (Stanford Linear Accelerator Center, Calif.). May 1969. 6p. (CONF-690510-2). Dep. CFSTI.

From DECUS Symposium, Wakefield, Mass.

The spiral reader is a semiautomatic film digitizing machine developed by the Alvarez Physics Group at the Lawrence Radiation Laboratory at Berkeley. It is used to measure photographs of elementary nuclear particle interactions which are created in a hydrogen bubble chamber. The entire man-machine-computer has proven to be accurate and reliable on the digitization. At Stanford Linear Accelerator Center (SLAC) a modified spiral reader was built to measure bigger areas, and to handle different film formats. A PDP-9 computer was selected to control and to acquire data. Practically every I/O feature on the PDP-9 was used to minimize external electronic interface and to make the control program more efficient. The PDP-9 computer performs the following functions: It guides the operator through the measuring sequence and types out warning messages on the teletype if the operator makes an error. It passes the digitized data through the DMA channel to magnetic tape, and displays the data on the storage scope. It keeps track of the stage positions and the periscope position through the add-to-memory feature. It monitors the spiral reader for any electrical or mechanical malfunction. It checks operator's efficiency and performs bookkeeping on events measured and events rejected, etc. The entire spiral reader system at SLAC is in operation, and it is capable of producing over 70 events per hour. (auth)

**29223** HIGH-VOLTAGE PULSING APPARATUS FOR A SPARK CHAMBER. Romanowski, Thomas A.; Rush, Charles J. (to United States Atomic Energy Commission). U. S. Patent 3,447,032. May 27, 1969.

This patent relates to a spark chamber embodying a plurality of spark chamber gaps defined by spatially mounted plate electrodes wherein a capacitor is provided for each spark chamber gap and has one side thereof connected through the center conductor of a coaxial cable to an associated plate electrode. The other plate electrodes are connected to electrical ground through the outer conductors of the coaxial cables. A voltage supply charges the capacitors and a spark chamber trigger switch responsive to spark chamber logic circuitry effects transfer of the capacitor charge to the plate electrodes. (AEC)

**29224** PULSE-SHAPING TRANSMISSION-LINE TRANSFORMER FOR A DOUBLE-GAP STREAMER CHAMBER. Odian, Allen C.; Villa, Francesco; Bulos, Fatin; Yount, David Eugene (to United States Atomic Energy Commission). U. S. Patent 3,445,661. May 20, 1969.

This patent relates to a large streamer chamber in which all parts are equally energized with a high-voltage pulse that has a duration on the order of the chamber length. The chamber is directly energized as a transmission line from a five-element transmission-line transformer matched to the characteristic impedance of the chamber. The transformer is charged from a Marx generator through a spark-gap switch. The chamber is terminated with a resistance equal to the characteristic impedance of the chamber. (AEC)

**29225** EMISSION MONITOR (Engineering Materials). (Cambridge Electron Accelerator, Harvard, Mass.). (CAPE-1874).

9 drawings.

A portable 10 in. secondary emission monitor is described which is used to monitor external beams at electron accelerators. The monitor has been used at the Cambridge and Stanford linear accelerators. The monitor's response for electrons from 1.5 to 18 GeV and positrons at 6 and 11 GeV was measured. (For details see TID-4100 Suppl. 53) (See also NSA 23: 7730). (F.S.)

**29226** "MIRABELLE" AND THE LARGE BUBBLE CHAMBERS. Nguyen, Q. (Centre d'Etudes Nucleaires, Saclay, France). Ind. At., 13: Nos. 3-4, 57-67; 69-70(1969). (In French).

Today elementary particle physics spearheads the research on the structure of matter. During the last two decades it has vastly developed its experimental apparatus, in particular the particle accelerators and the bubble chambers. "Mirabelle," a large liquid hydrogen bubble chamber now being set up in the Department of Elementary Particle Physics of the Saclay Nuclear Study Center, has a photographable volume of 6 $m^3$. It is expected to be completed this year. After it has been tested it will be sent to Serpukhov (USSR) to be used for a minimum period of five years in conjunction with the 70 BeV accelerator. (auth)

**29227** ROLE OF HEAVY LIQUID BUBBLE CHAMBERS IN ELEMENTARY PARTICLE PHYSICS. Rousset, Andre (Ecole Polytechnique, Paris). Ind. At., 13: Nos. 3-4, 41-5; 47-8(1969). (In French).

The use of heavy-liquid bubble chambers in high-energy physics research is described. In particular the study of the meson ($\eta^0$), the form factor for $K^+ \rightarrow \mu^+ + \pi^0 + \nu$ decay, and the decay $K^0_S \rightarrow \pi^0 + \pi^0$ using heavy-liquid bubble chambers are described. (J.F.P.)

**29228** ANALYSIS OF BUBBLE CHAMBER PHOTOS. Laberrigue, Jeanne (CNRS, Paris). Ind. At., 13: Nos. 3-4, 49-56 (1969). (In French).

The interest and the growth of studies made analyzing bubble chamber photos are pointed out. These have led to vital results in the study of the properties of fundamental particles. The various techniques employed to carry out such studies are described and the stages of analysis are listed from the use of extremely precise measuring apparatus, now in process of automation, to that of the major computers which allow vast statistics to be handled and make it possible to use bubble chambers both as exploratory and as high precision instruments. (auth)

## Radiation Dosimeters

**29229** (AD-681497) EFFECTS OF LABORATORY REPROCESSING ON SILVER PHOSPHATE GLASS MICRODOSIMETERS. Report for January 1966-March 1967. Hardy, Kenneth A.; Werts, Rufus (School of Aerospace Medicine, Brooks AFB, Tex.). Sept. 1968. 12p. (SAM-TR-68-96). CFSTI.

The purpose of this three-phase experimental study was to determine the effects of laboratory reprocessing on silver phosphate glass rod microdosimeters. Results show that the microdosimeters may be brought back to their nonirradiated condition by heating at 450°C for one hour. According to these studies, a small loss of sensitivity occurs after the initial reprocessing but the linearity does not appear to be affected. Further reprocessing gave no apparent loss in sensitivity even after repeated exposures up to a cumulative dose of 97,500 R. (auth) (USGRDR)

**29230** (AD-681891) SILVER PHOSPHATE GLASS DOSIMETRY AND ITS USE AT THE US ARMY NUCLEAR DEFENSE LABORATORY. Gibson, Nancy N. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Nov. 1968. 29p. (NDL-TM-48). CFSTI.

The report describes the use of silver phosphate glass for gamma dosimetry. Silver phosphate glass rods provide inexpensive and reliable measurements of gamma exposures from 10 to 100,000 R. With energy discrimination shields and $^6$LiF thermal neutron shields, the system is essentially photon-energy independent and is insensitive to thermal neutrons. Fast neutron responses were measured at neutron energies from 1 to 14 MeV. (auth) (USGRDR)

**29231** (CNEA-232) DOSIMETRY OF PHOTOGRAPHIC EMULSION FOR MEASURING HIGH DOSES OF GAMMA RADIATION. Gomez, Aristobulo L.; Mugliaroli, Hugo A.; de Gomez, Clara M. L. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1968. 14p. (In Spanish). Dep.

The performance of a film dosimeter which has independent energy response between 1.25 and 30 keV is described. Exposure ranges from 100 to 800 R. Densitometric measurements in several areas of the film with a stepwedge metallic filter allow the reading of the exposure using an experimental calibration curve. Maximum error is ±15%. Commercial film and conventional developing procedures were used. Also, the following possibilities are discussed: extending the detection range using additives to the developer; using the dosimeters in nondirectional radiation fields; and making an absolute type calibration using the statistical collection readings method. (auth)

**29232** (THAI.-AEC-23) SOME EXPERIENCES IN NEUTRON DOSIMETRY. Hayodom, Vichai; Boonkong, Wunlop; Mahapanyawong, Sakow; Chaimonkon, Chavee (Office of Atomic Energy for Peace, Bangkok (Thailand)). 1969. 10p. Dep.

Neutron dosimetry equipment and methods, mainly foil activation techniques, are discussed. Cross sections and resonance integrals for various foils are presented, and flux density and dose measurement techniques are described. (W.H.K.)

**29233** IMPROVEMENTS IN OR RELATING TO NUCLEAR DOSIMETERS. (to Commissariat a l'Energie Atomique). British Patent 1,153,095. May 21, 1969. Priority date Sept. 22, 1966, France.

A simple dosimeter comprising a mixture of thermoluminescent lithium fluoride and photosensitive cadmium sulfide sealed in a tube with a heating resistor and external circuits including a power

source for the heater and a voltmeter for reading the charge from the photosensitive cadmium sulfide is described. This method of readout eliminates the costs and complications of photomultiplier systems. (W.H.K.)

**29234** POCKET RADIATION DOSIMETER UTILIZING CAPACITOR INTEGRATOR. Smith, Marvin L. (to United States Atomic Energy Commission). U. S. Patent 3,443,097. May 6, 1969.

This patent relates to a radiation-measuring device which comprises a radiation counter tube and a capacitor integrator connected to integrate the output of the counter tube. An alarm actuates response to a predetermined storage voltage of the capacitor integrator and a radiation source coupled to the counter tube provides therefrom a compensatory signal for electrical leakage of the capacitor integrator. (AEC)

**29235** THE ESTIMATION OF RADIATION QUALITY AND EXPOSURE OF X-RAYS FROM THE DEPTH DOSE DISTRIBUTION IN SILVER-ACTIVATED PHOSPHATE GLASSES. Kiefer, H.; Piesch, E. (Kernforschungszentrum, Karlsruhe, Ger.). Atompraxis, 15: 108-14(Mar.-Apr. 1969). (In German).

A differential fluorescence evaluation method is described to determine the radiation quality and the exposure of x-rays using silver-activated metaphosphate glasses and scanning continuously the homogeneous solid-state detector. In this way it is possible to derive the effective quantum energy from the depth dose distribution in the glass for defined radiation incidences by a comparison with the calibration curves, by a relative dose decrease (ratio of dose reading in a definite glass depth of the dose reading on the surface), and by the first HVL in the glass. With the knowledge of the radiation to the radiation quality, a free-air exposure may be ascertained by considering the dose sensitivity in the corresponding glass depth. The method of dose determination is explained by employing a graphic evaluation technique as well as simplified evaluations techniques for two component radiation mixtures and inhomogeneous x-rays bremsstrahlung in the energy range of 10 to 300 keV achieving a measuring accuracy of 5 to 30%. The described method is appropriate for the check and control of medical and technical x-ray machines (radiation quality, tube output). The phosphate glass can be used, too, as a long-time accumulation spectrometer to measure radiation and stray radiation fields in radiation protection. (auth)

**29236** DOSIMETRIC METHOD OF $\gamma$ RADIATION USING AN AQUEOUS SOLUTION OF OXALIC ACID. Hara, E. (Hitachi Central Research Lab., Tokyo). Int. J. Appl. Radiat. Isotop., 20: 395-7(May 1969).

It was reported that the amount of decomposed oxalic acid is proportional to the absorbed dose when the decomposition is lower than 30% of the initial concentra on, and that the decomposition rate decreases with increase of ose. In the studies described the amount of oxalic acid remaining in irradiated samples was measured by titration with $KMnO_4$. It was realized that $KMnO_4$ also decomposes other products from the radiolysis of oxalic acid, but for practical purposes the method is very useful in connection with use of the oxalic acid system in dosimetry, in conjunction with calibration by a reliable dosimetric system such as ferrous sulphate. Oxalic acid solutions of concentrations 25, 50 and 100 mM/l were $^{60}Co$ $\gamma$-irradiated in the ranges $8 \times 10^5$ to $7 \times 10^6$, $1 \times 10^6$ to $1 \times 10^7$, and $1 \times 10^6$ to $4 \times 10^7$ R, these doses being determined by use of ferrous sulphate. Over the dose rate range of $4 \times 10^4$ to $5 \times 10^5$ R/hr no dose rate dependency was observed, and the reproducibility seemed almost perfect. For an initial concentration of 50 mM/l the relationship between irradiation dose and decrease in amount of $KMnO_4$ in the titration was always linear when data were plotted on log/log scale. (UK)

## Radiometric Instruments

*Refer also to abstracts abstracts 29101, 29621, and 30092.*

**29237** THE RELIABILITY OF SOIL DENSITY MEASUREMENTS USING NUCLEAR METHODS FOR DIFFERENT SOILS. Dobo, I. (Office for Hydraulic Planning, Budapest). Acta Tech. Acad. Sci. Hung., 63: 49-56(1968).

Experiments were carried out to assess the applicability of a nuclear absorption apparatus for measuring the unit weight of soil, special consideration being given to the influence of soil type and water content. The probe designed to measure the moist unit weight (bulk density) of the top 30-cm thick layer of earth structures operates on the principle of $\gamma$-ray absorption. The tests were designed to provide information on differences in density recorded by the nuclear method when soils of different type and moisture content were compacted to the same moist unit weight. The following materials were included in the test series: sand, sandy gravel, lean clay, fat clay, bentonite, and hydrated lime (mixed with sand). The moisture content of the samples tested ranged from 2 to 70% by weight. Comparison of the relative reliabilities of the conventional and nuclear methods in undisturbed clay soil of uniform density at 2 to 3 depths below the terrain surface showed that the scatter of densities obtained by the conventional method was consistently wider than that of nuclear measurements. It was concluded that the reliability of the nuclear absorption method is considerably higher than that of the conventional method. (BBB)

**29238** MEASURING ABLATION SHIELD THICKNESS. Chope, Henry R. (to Industrial Nucleonics Corp.). U. S. Patent 3,439,166. Apr. 15, 1969. Filed Nov. 4, 1964.

For measuring the thickness of the nose section or outer skin or wall of a space vehicle during re-entry one or more nucleonics sensing devices are provided on the nose section of the vehicle. Two approaches are described. One approach uses a penetrating radiation source and detects the backscattered radiation from the outer skin or wall. Various simple or compound radiation sources can be used in this first method. Among those described and generically or specifically claimed are (1) a gamma radiating source, (2) a beta excited x-ray source, and (3) a novel compound beta-bremsstrahlung x-ray source. (auth)

**29239** NEW METHOD FOR GAMMA-LOG INTERPRETATION. Resler, Rolf. At. Energ. (USSR), 26: 337-40(Apr. 1969). (In Russian).

A new method free of subjective influence is described, for interpreting gamma-ray-logs. The radioactive material is assumed to be constant by layers. The counting rate recorded at points equi-distant along a borehole is connected by a system of linear equations with the content unknown. This system of equations may be solved for different geometric relations and the interpretation is reduced to some multiplication and additions which can be easily automated. The method is successfully used in prospecting for potash and uranium in the GDR. (auth)

**29240** MASSIVE-USE SPECTROMETRIC SCINTILLATION APPARATUS FOR RADIOACTIVE LOGGING OF BOREHOLES IN ORE DEPOSITS. Migunov, B. B.; Kholin, V. N.; Kharitonov, S. E. Geofiz. Sb., Akad. Nauk Ukr. SSR, Inst. Geofiz., No. 23, 80-4(1968). (In Ukrainian).

A model of equipment for radioactive spectrometric logging has been developed by the National Research Institute of Nuclear Geophysics. Tests in the Krivoy well axis; at a chosen distance from the source (a few tens to 100 m) the minimum and material components (or amplitude and phase) of the three mutually perpendicular spatial components of the magnetic field are measured: the axial and two transverse to it. The method was developed in 1959, and apparatus is now being produced serially. The physical basis of interpretation and some results of model studies, together with examples of the practical application, are discussed. (Geophys. Abstr.)

**29241** HEAT RESISTANT SCINTILLATION COUNTER. Arm, E. M.; Govorova, R. A.; Evtushenko, V. F.; Nedostup, G. A. Geofiz. App., No. 33, 130-2(1967). (In Ukrainian).

A scintillation counter that can withstand temperatures up to 120°C in radioactivity logging is described briefly. (Geophys. Abstr.)

**29242** MODERNIZATION OF THE DRST-1 RADIOMETER. Nelepchenko, O. M. Geofiz. App., No. 33, 164-9(1967). (In Ukrainian).

Improvements in the DRST-1 radiometer include enhancement of the efficiency of the neutron–gamma logging channel, visual control of the tuning of the channels, increasing its resistance to vibration, and variation of nominal values of the constant time. (Geophys. Abstr.)

**29243** FEATURES OF THE USE OF CORRECTION INTEGRATORS IN RADIOMETRIC APPARATUS. Bragin, A. A.; Fedoriv, R. F. Geofiz. App., No. 33, 133-42(1967). (In Ukrainian).

Use of the usual linear integrators in radiometric apparatus, particularly in logging radiometers and spectrometers, does not eliminate nonlinearity due to counting errors of the detectors and inertia of the electronic scheme of the measuring circuit. Linearization of the scale of the records is provided for easily by the so-called correction integrator. Introducing a correction circuit changes the constant time of the transient process and correspondingly the statistical error of the measurements. In this connection the choice of optimal method of connecting the scale and calibrating the gage of the record is important. The general aspects of the correlation of nonlinearity of the scale of a correction integrator are examined and integrators with metering switch and with metering capacitance are described. (Geophys. Abstr.)

**29244** MEASUREMENT OF LOW CONCENTRATIONS OF MOISTURE BY FAST NEUTRON MODERATION. Semel, Stanley; Helf, Samuel (Picatinny Arsenal, Dover, N. J.). Int. J. Appl. Radiat. Isotop., 20: 229-39(Apr. 1969).

The fast neutron moderation technique was applied for the measurement of moisture content in materials in concentrations under 1 wt %. With a 5 Ci plutonium-beryllium (Pu-Be) fast neutron source, the sensitivity for water (or other hydrogenous matter) determination approaches 0.1 wt % as the lower limit with 400 $cm^3$ samples of either solids or liquids. The presence of inherent molecular hydrogen or strongly thermal neutron absorbing elements in the medium has no appreciable effect on the ability to analyze for such small concentrations of moisture. The method is particularly applicable to laboratory or plant quality control where moisture content must be determined to within specific limits. (auth) (UK)

**29245** EXTENDED TESTING OF THE METHANE IONIZATION DETECTOR. Finkel, Joel R.; McCabe, Philip J. (Melpar, Inc., Falls Church, Va.). Isotop. Radiat. Technol., 6: 368-75 (Summer 1969).

The development, construction, and performance of an instrument for the detection of methane during coal mining operations are described. The equipment can be directly attached to the coal-digging machine and is capable of withstanding the abuse and hostile conditions associated with the mining process: high humidity, violent vibrations, and large voltage surges. Two alarm levels are provided for triggering at concentrations of either 1 or 2% methane. Details of the tritium detector cells, electronics, and mechanical construction are presented. (auth)

**29246** COMPARISON OF X-RAY AND BETA RAY TECHNIQUES FOR MEASURING WOOD DENSITY. Harris, J. (Forest Research Inst., Whakarewarewa, New Zealand); Polge, H. J. Inst. Wood Sci., 19: 34-42(Sept. 1967).

Two methods of obtaining continuous records of wood density variation from small radial samples, such as can be obtained with an increment borer, are compared as to cost, ease and speed of operation, and quality and reliability of the results. (auth)

**29247** MINIATURE NEUTRON TUBE. Chrusciel, E.; Massalski, J.; Pieczora, K.; Starzec, A. (Inst. of Nuclear Techniques, Krakow). Nucl. Instrum. Methods, 71: 205-7(1969).

The construction and technology of miniature neutron tubes designed at the Institute of Nuclear Techniques are described. The diameter of the tube is 24 mm and the length 140 mm. The tube is used in a bore-hole probe of neutron generator; in addition to its main purpose, i.e., acting as neutron source, the tube also works as a HV rectifier. The output of the tube is $2 \times 10^7$ n/s for pulsed operation at the accelerating voltage of 100 kV, neutron pulse width 100 $\mu$s, repetition rate 400 Hz. (auth)

**29248** EQUIPPING OF HYDRAULIC PRESSES WITH A RADIOISOTOPE DEVICE FOR AUTOMATIC CONTROL. Maksin, Yu. A.; Vasil'ev, K. I.; Etin, I. Z. Kuznechno-Shtampovochnoe Proizvod., No. 5, 34-8(1968). (In Russian).

The introduction of high-precision die forging is feasible only on the basis of automatic dimensional control. In this connection, an automatic control system has been introduced at a number of Leningrad plants which consists of an SShT-11 universal press-forging meter and a servosystem for transmitting instructions from that meter to the press distributor. The SShT-11 meter operates on the principle of a contactless radioisotope switch. A beta radiation source is mounted on the moving press frame and a gas-discharge counter-emission sensor is mounted on a carriage adjusted to the desired level. The position of the carriage is continually recorded with the aid of a selsyn coupling on a pointer dial. During downstroke of the press frame the flux of beta radiation strikes the sensor which then sends a "Stop" or "Reverse" signal to the control unit for stopping or reversing the moving frame. The triggering time of the electrical circuit of the SShT is ≥0.2 sec but eventually will be reduced to 0.06 sec. Measurements of press forgings by this method in 2000- and 3000-ton presses have shown that the use of the automatic control system can enhance the precision of the produced forgings by ±3-5 mm, which is 2-3 times as high as in manual control of press operation, thus making it possible to reduce the tolerances for the forgings. The automation of the measurements of forgings and of the control of hydraulic forging presses enhances forging precision, increases the number of press strokes, and markedly improves the quality of forgings and eases working conditions. Press stopping time can thus be reduced 10 to 15% and planishing time, 25 to 30%. (JPRS)

# Miscellaneous Instruments and Components

*Refer also to abstracts 30091, 30640, and 31223.*

**29249** (AECL-3159) AN AUTOMATIC TITRATOR FOR THE KARL-FISCHER DETERMINATION OF WATER. Wuschke, E. E.; Stewart, R. B. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Oct. 1968. 12p. Dep. CFSTI. CAN $0.50.

An automatic titrator suitable for the determination of water by the Karl-Fischer method is described. Control of reagent flow is entirely automatic, and a timer is included to avoid transient end-points. The measurement of water in organic reactor coolants with precisions of 2 ppM in the 0 to 100 ppM range are attainable. The titrator contribution to this error is negligible. (auth)

**29250** (DNPL/P-5) THE USE OF DATA LINKS TO THE IBM 360 SYSTEM AT DNPL. Brooks, J. R.; Daniels, T.; Heyes, P.; Peatfield, A. C.; Zacharov, B. (Daresbury Nuclear Physics Lab. (England)). Mar. 1969. 26p. (CONF-690321-1). Dep. From International Conference on Remote Data Processing, Paris, France.

Data links are used at DNPL for communications between small computers local to nuclear experiments and the central 360/65 system. They are also used to connect data terminals for man-machine interaction. A short review is given of the implementation and exploitation of typical links developed at DNPL and, in particular, the fast links to remote PDP8 computers. The operation of a satellite IBM 1800 used as a buffer-multiplexing terminal is also described. Experience of some man-machine interactions, facilitated by the use of data links, is briefly summarized. (auth)

**29251** (KFK-950) LIST OF SCIENTIFIC PUBLICATIONS OF THE KARLSRUHE NUCLEAR RESEARCH CENTERS OF THE YEAR 1968. (Kernforschungszentrum, Karlsruhe (West Germany)). Mar. 1969. 75p. (In German and English).

Topics include nuclear physics, reactor physics, neutron physics and reactor technology, nuclear processing techniques, materials and solid state research, reactor structural elements, reactor development, high-temperature chemistry, radiation chemistry, radiation biology, schools for nuclear technology, reactor operation, cyclotron development, radiation protection and decontamination, low-level radioactive waste, electronics and measuring techniques, medicine, library and documentation, construction engineering, patents and license, isotope technology, and experimental layout. (W.H.K.)

**29252** (RPI-328-148, pp 48-50) INSTRUMENTATION DEVELOPMENT. (Rensselaer Polytechnic Inst., Troy, N. Y.).

Data acquisition programs for the PDP-7 computer are briefly described. (C.E.S.)

**29253** (THAI.-AEC-6) NUCLEAR INSTRUMENT DEVELOPMENT. (Office of Atomic Energy for Peace, Bangkok (Thailand)). July 1968. 19p. Dep.

The applications and specifications for various nuclear instruments are presented including a single channel analyzer, model 1111; portable survey meter, model 2101; portable scaler, model 1203; decade scaler, model 1201; precision linear ratemeter, model 1501; high speed scaler, model 1202; gamma-ray spectrometer, model 1911; amplifier-discriminator plug-in unit, model 1301; amplifier-analyzer plug-in unit, model 1310; high voltage plug-in unit, model 1401; and timer model 8111. (W.H.K.)

**29254** NEUTRON-DIFFRACTION EQUIPMENT WITH VARIABLE WAVE LENGTH. Kuvaldin, B. V.; Lipin, Yu. V. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 1, 33-6(1969). (In Russian).

The equipment is located in the exit channel of the reconstructed thermal column of a reactor IRT·2000. The neutron flow in the monochromator region at the divergence of the primary beam of 35′ was found to be $2.8 \cdot 10^8$ n/$cm^2$ per sec. Ferrosilicon monocrystal is used as monochromator. The divergence of the monochromatic beam may reach the value of 52′, 26′, 17′ and 13′ owing to a section collimator. The equipment enables the angle and the energetic analysis of the neutrons to be carried out. The transitions and the angle reading are conducted by remote control at reading error ±1. (auth)

**29255** IMPROVEMENTS RELATING TO LIQUID LEVEL GAUGES. Bradstreet, Derek; Somerville, Walter Albert (to United Kingdom Atomic Energy Authority). British Patent 1,153,089. May 21, 1969. Filed Apr. 27, 1967.

Reference is made to a gage which comprises a series of liquid level detector elements for a range of different levels, each such element having the capability of determining the presence or absence of liquid at the level of the element, with provision of a scanning means, and a display means. The detector elements may be thermocouples or thermistors. Application to a liquid sodium system is described. (UK)

**29256** NEUTRON DIFFRACTOMETER DELIVERED TO THE SOLID STATE PHYSICS INSTITUTE OF TOKYO UNIVERSITY. Hoshino, Sadao (Tokyo Univ.); Tsuda, Eiichi. Mitsubishi Denki Giho, 43: 571-8(Apr. 1969). (In Japanese).

A large neutron diffractometer has been delivered to the Solid State Physics Institute of Tokyo University and set up to a JRR-3 reactor of the Japan Atomic Energy Research Institute. With this diffractometer two other small diffractometers can be put in use at the same installation. That means it is provided with a monochrometer which permits taking out three monochromatic beams from one beam hole of the reactor. There are three measuring systems of diffracted beams with the goniometer so as to reduce the measuring time of powder specimen. The measurement control circuits involve parts which are turned to solid state, module and integrated circuits, thus small size and easy maintenance being taken into consideration. It has such performance as to be claimable of nearly perfect radiation shielding; the surface dose rate is made nearly below 2 mR/h. (auth) (NSA of Japan)

**29257** THE USE OF A CONTROL COMPUTER IN A CHEMISTRY DEPARTMENT. Okaya, Y. (State Univ. of New York, Stony Brook). IBM J. Res. Develop., 13: 126-31(Jan. 1969).

The Chemistry Department of the Stony Brook Campus of the State University of New York is composed of a number of faculty members whose research experiments fall generally into two categories; (1) steady data acquisition and control tasks with relatively small data and demand rates, and (2) continuous scan-type measurements of various data rates. An IBM 1800 control system is employed as the nerve center of a computer-based experiment complex. This paper discusses the multi-experiment control system used at Stony Brook Chemistry, giving some details of experiments performed by faculty members as examples of its application. It is pointed out that one of the objectives of this computerized department is creation of a course in the use of computers in chemistry. With a data-acquisition computer available in the department, the course can include actual bench practice in data acquisition and control tasks. (auth)

**29258** ABSOLUTE MICROMANOMETER USING DIAMAGNETIC LEVITATION. Evrard, R. (Laboratories d'Electronique et de Physique Appliquee, Limeil-Brevannes, France); Boutry, G.-A. J. Vac. Sci. Technol., 6: 279-88(Mar.-Apr. 1969).

A friction-free suspension in vacuo is provided for a graphite disk by magnetic induction. The disk rotates around a vertical line of force inside a properly designed stator; when the stator is cooled, a thermomolecular torque is developed and the acceleration thus given to the disk is measured by an automatic device. It is shown that this acceleration depends only on the geometrical design of the manometer and on the pressure to which it is proportional. The manometer unit is passive, very small, and insensitive to vibrations and shocks affecting the vacuum setup. The lower limit of its range of measurement is less than $10^{-10}$ Torr. When stator cooling is removed, the disk is influenced only by a (smaller) molecular damping torque. This depends on the composition of the residual atmosphere; provided this is known, the magnitude of the damping can be computed a priori with good precision so that the instrument becomes a useful standard manometer for calibration in the $10^{-3}$ to $10^{-7}$ Torr range. (auth)

**29259** BURIED COLLECTOR GAUGE FOR MEASUREMENTS IN THE $10^{-11}$ TORR PRESSURE RANGE. Melfi, Leonard T. Jr. (Langley Research Center, Hampton, Va.). J. Vac. Sci. Technol., 6: 322-5(Mar.-Apr. 1969).

A nude ionization gauge is described in which a shielded collector is used to lower the x-ray current. Pressures as low as $4 \times 10^{-12}$ torr have been indicated with an estimated x-ray current corresponding to a pressure below $2.6 \times 10^{-12}$ torr. Calibration of the gauge on an orifice flow-rate system in the pressure range between $10^{-6}$ and $10^{-9}$ torr with 4-mA emission and a collector to filament voltage of −300 V, yielded a gauge constant of 20 $torr^{-1}$. For pressure below $10^{-9}$ torr the buried collector gauge was compared to the bent-beam Helmer gauge. Data from tests performed on the bent beam Helmer gauge are also given. These include a calibration and a plot of gauge constant as a function of emission current in the range between 0.1 and 10 mA. (auth)

**29260** REAL-TIME REDUCTION OF NUCLEAR PHYSICS DATA. Bevington, P. R. (Stanford Univ., Calif.). IBM J. Res. Develop., 13: 119-25(Jan. 1969).

Small scientific computers have been widely used in research laboratories for on-line data acquisition to improve the efficiency of data collection and to perform sophisticated data manipulation before storage. An equally productive use of such computers is for the subsequent reduction of these data in real time, permitting interaction between investigator and computer and providing immediate interpretation of masses of data. This report describes the philosophy and techniques developed for the SCANS (Stanford Computers for the Analysis of Nuclear Structure) system for the reduction in real time of multichannel pulse-height spectra, which comprise the bulk of data in Nuclear Physics. The programming language for users is FORTRAN, to provide flexibility and ease in introducing and modifying sophisticated concepts such as nonlinear least-squares fitting. Software interface to specific real-time hardware devices such as oscilloscope display and light pen is accomplished via library subroutines which perform a variety of general purpose service. Several different applications of this approach to various types of data spectra are discussed to illustrate the degree of mutual interaction achieved between investigator and computer and the resultant optimization of reduction techniques to suit particular types of data. (auth)

**29261** INTERACTIVE GRAPHICS SYSTEM FOR NUCLEAR DATA ACQUISITION. Birnbaum, J. (Thomas J. Watson Research Center, Yorktown Heights, N. Y.); Kwap, T.; Mikelsons, M.; Summers, P.; Schofield, J. F.; Carrubba, F. IBM J. Res. Develop., 13: 52-60(Jan. 1969).

The graphics terminal described was developed for low-energy nuclear-physics data acquisition and control, and is currently in use at the Yale University Wright Nuclear Structure Laboratory as part of an IBM System/360 Model 44-based system. It is comprised of dual cathode ray tube displays, a light pen, and function keyboard, and includes character generation, display simulation, and photographic facilities. It is capable of plotting 200,000 points per second with variable intensity. The display programming structures, which support highly interactive communication between physicist and computer, are discussed in detail. A data acquisition programming system permits the creation and manipulation of self-describing global data and display entities. Examples of the resultant increased experimental sophistication and efficiency are presented. (auth)

**29262** COMPUTER FACILITIES FOR THE LABORATORY. Lusebrink, T. R.; Sederholm, C. H. (IBM Scientific Center, Palo Alto, Calif.). IBM J. Res. Develop., 13: 65-74(Jan. 1969).

Digital computers have become indispensable aids for many laboratory disciplines, allowing the performance of experiments which would be infeasible without the aid of a computer. Until recently, these computations have usually been carried out off-line, i.e., experimental data have been acquired in real time and subsequently processed on a large central computer. Small, relatively inexpensive digital computers first entered the laboratory as a substantial aid in real-time acquisition of data and control of experiments. Such computers, however, suffer severe limitations with regard to ultimate processing of the data. Hence the data processing must still generally be done on a large computer. To realize the full potential of computer-instrument interaction, one should use the computer to: acquire data while performing requisite control of an experiment; calibrate, reduce, and compare the data with files of known physical parameters or theoretical calculations; and finally, produce desired reports and documentations of the experiment. In order to obtain results soon enough to effect the next experiment, i.e., in minutes, or at most, tens of minutes, all of the foregoing steps should preferably be carried out in a single computer. Fulfilling all of these needs requires a computer too large and expensive to be dedicated to most single experiments. Therefore, a computer shared among several instruments is required. A computer system which simulates the independence of small dedicated computers, but which is also capable of performing medium- to large-scale computations when they are required, is most desirable. Of course, many of these statements are controversial, and in order to investigate the validity of this approach an experimental computer system has been designed and implemented specifically for automation of multiple laboratory instruments in a time-shared mode. Experience gained from the simultaneous operation of a mass spectrometer, a nuclear magnetic resonance spectrometer, and two gas chromatographs is presented. The application programs and some proposed augmentation of these programs are also discussed. (auth)

**29263** USE OF A TIME-SHARING COMPUTER IN NUCLEAR CHEMISTRY. Fryklund, J.; Loveland, W. (Oregon State Univ., Corvallis). IBM J. Res. Develop., 13: 75-8(Jan. 1969).

The Oregon State University computer-analyzer system couples the advantages of on-line data acquisition and analysis with the low cost of a time-sharing computer. The system operates in two

modes. In Mode A, a 4096-channel analyzer serves as a data acquisition and buffer storage device with the contents of the analyzer memory being transmitted via telephone lines to the Oregon State University computer for analysis. In Mode B, the correlated outputs of N analog-to-digital converters (corresponding to an N-parameter event) are transmitted to the computer in real time for storage and analysis. Additional information, programming and computations may be entered at any time from a remote terminal console. The results of the data analysis can be returned immediately to the remote terminal console or to any regular computer output device. This system has the advantages of being able to utilize the full facilities of a large computer, its FORTRAN compiler, etc., for on-line data acquisition and analysis while avoiding the responsibilities of hardware maintenance and systems programming for the nuclear chemists. (auth)

**29264** GROWTH OF A LABORATORY COMPUTER SYSTEM FOR NUCLEAR PHYSICS. Mollenauer, J. F. (Bell Telephone Labs., Inc., Murray Hill, N. J.). IBM J. Res. Develop., 13: 87-92(Jan. 1969).

A computer system may typically be expected to progress through a cycle terminating in overloading. The experience with an early system at the author's nuclear physics laboratory serves as an example. The original computer and a similar machine later installed with it are now overloaded and a new system is under construction. The success of the interactive data analysis on the original system has made it desirable to enhance the display and light pen facilities while reducing the computer time involved in generating the displays. The use of a data storage/display disc effectively provides off-line displays but requires more manipulation in data acquisition. The solution is found in the large number of processing units economically feasible with third-generation equipment. Two linked computers will perform data acquisition and analysis, the smaller performing data acquisition under the control of the larger, which will run a fairly simple time-sharing system. Together with several I/O processors, this hierarchy of processors will provide ease of program development and a very high degree of computational power and data acquisition capability. (auth)

**29265** THE USE OF COMPUTERS AT CERN. Bell, R. T.; Oeveras, H. (CERN, Geneva). IBM J. Res. Develop., 13: 104-13 (Jan. 1969).

This paper surveys the many ways computers and connected special devices are used in the laboratory of high energy nuclear physics research of CERN (European Organization for Nuclear Research) in Geneva, Switzerland. (auth)

**29266** EXPERIMENTAL SYSTEM FOR TIME-SHARED, ON-LINE DATA ACQUISITION. Reich, H. A. (Columbia Univ., New York). IBM J. Res. Develop., 13: 114-18(Jan. 1969).

With the increasing availability of terminal-oriented, time-shared computers, it now becomes feasible to extend the method of use to include real-time, on-line data acquisition and data reduction. Here described is a particular embodiment of such a system using an IBM 1050 terminal and the IBM Research M44/44X and the APL/360 Model 50 computers. Reasons leading to the choice of equipment, special devices, programming considerations, data rates and some economic factors are considered. (auth)

**29267** CONFERENCE ON INDUSTRIAL MEASUREMENT TECHNIQUES FOR ON-LINE COMPUTERS, LONDON, 11TH-13TH JUNE, 1968. Conference Publication No. 43. London, Institution of Electrical Engineers, 1968. 163p. (CONF-680653).

Separate abstracts were prepared for 2 of the 23 papers presented. The remaining 21 papers were not within the scope of NSA. (W.H.K.)

*For abstracts of individual papers see: 31132 and 31240.*

**29268** ELECTRONIC PARAMAGNETIC RESONANCE SPECTROMETER FOR NUCLEAR REACTORS. Galland, Daniel; Perrin, Jacques; Santier, Christian; Servoz-Gavin, Pierre; Soutif, Michel (to Commissariat a l'Energie Atomique). British Patent 1,152,779, May 21, 1969. Priority date Sept. 5, 1966, France.

Apparatus for the study of irradiated specimens by electron paramagnetic resonance is described. The system comprises a cavity resonator for containing said specimen, a solenoid in which the cavity resonator is disposed for producing a continuous, stable and homogeneous magnetic field in the cavity resonator, a pole for supporting the solenoid and the cavity resonator in the vicinity of the core of a swimming pool nuclear reactor, the solenoid being arranged to be cooled directly by the water of the swimming pool, a spectrometer and means for supplying electric current to the solenoid via the pole, the solenoid comprising a main coil formed by two co-axial windings connected electrically together in series or in parallel, and separated by an insulating screen, and an auxiliary coil for compensating heterogeneity of the first degree in the magnetic field produced by said two windings in at least said cavity resonator, the auxiliary coil being formed by two co-axial windings disposed one on either side of a median plane of the main coil. (auth)

**29269** DIFFERENTIAL CONVERTER FOR NUCLEAR LEVEL LIFETIME MEASUREMENTS. Berlovitch, E. E.; Kotchkin, V. A.; Lukashevitch, V. V.; Popov, A. V.; Romanov, V. M. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Instrum. Methods, 71: 99-101(1969).

A differential converter comprising two conventional converters, a differential amplifier, a generator, and a summing device is described. In lifetime measurements by the center of gravity shifting method the differential converter compensates for the instrumental effects which do not result in shifts of the centers of gravity of shaper pulses. Another distinguishing feature of the converter is stability of the time-amplitude conversion. Root-mean-square spread of the centers of gravity for coincidence curves with a $^{60}$Co source is not over $3 \times 10^{-12}$ sec for 12 h. (auth)

**29270** USE OF A PDP-8 COMPUTER FOR OPERATION OF SEVERAL NEUTRON BEAM EXPERIMENTS. Maslin, E. E.; Terry, S. H.; Wraight, L. A. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). Nucl. Instrum. Methods, 71: 13-26(1969).

A system is described, developed at the HERALD reactor at AWRE Aldermaston, in which a 4 K PDP-8 with DECtape serves up to 4 separate experiments concurrently in the role of multichannel analyzer, data processor, or automatic controller. Although only 28% of the core store is allocated to program, the remainder being available for storage of experimental data. A wide variety of features is provided. These include multiprogrammed operation of the experiments, data displays, and a range of operator facilities. Several problems encountered in developing the system are discussed together with their solutions. (auth)

**29271** MONOTRON OSCILLATOR WITH A SUPERCONDUCTING CAVITY. Biquard, Francis; Grivet, P.; Septier, Albert (Faculte des Sciences, Orsay, France). IEEE (Inst. Elec. Electron. Eng.) Trans. Instrum. Meas., 17: 354-8(Dec. 1968).

A description is given of a microwave oscillator of monotron type using a superconducting cavity. A monotron oscillator is a device where a continuous electron beam gives energy to the electromagnetic field of a single resonant cavity. Recent achievement of superconducting cavities having very high Q factors (Q = quality factor of the cavity) renders possible the realization of powerful microwave oscillators with a frequency stability as good as that of quartz clock. A brief survey of theoretical properties shows that this type of oscillator can have good short-term frequency stability ($10^{-14}$ for $\tau$ = 1 msec) and spectral purity ($2\delta f/f = 10^{-17}$). After a brief description of the oscillator, experimental results on threshold current are given for starting oscillation and frequency stability. It was shown that it is possible to realize an S-band oscillator with a frequency stability better than $10^{-10}$ and capable of delivering continuous power of the order of 100 mW. (BBB)

**29272** TANGENT FOCAL PLANE APPROXIMATIONS IN THE BROWNE-BUECHNER SPECTROMETER. Warshaw, S. I. (Univ. of Illinois, Urbana). Nucl. Instrum. Methods, 72: 5-12 (1969).

First order focusing for the magnetic spectrometer of Browne and Buechner is discussed in the approximation where the focal surface is taken to be the plane tangent to the actual hyperbolic focal surface at the image point for 90° bending. Expressions for magnification, dispersion, and related quantities are derived for arbitrary source-to-magnet distances, and compared with those for the hyperbolic case. Results of numerical calculations as applied to the University of Illinois 26" spectrometer are discussed. (auth)

**29273** NEW SERIES-CONNECTED TUNNEL DIODE SCALER. Tan, Z. C.; Hitchcock, J. A. G. (Univ. of Auckland, New Zealand). Nucl. Instrum. Methods, 72: 99-102(1969).

A new series-connected tunnel diode scaler which is free from multiple triggering is described. The tunnel diodes are biased at different current levels by extracting a part of the common bias current from each junction of the chain. These current drains are progressively removed as each tunnel diode forward switches, the bottom tunnel diode initiating reset of the system. A test circuit operated from 0 to 135 MHz with input current pulses of 1 to 2.5 ns duration, the maximum scaling rate being determined by the reset time. (auth)

**29274** CHANNEL MULTIPLIER OPERATION IN A REDUCED TEMPERATURE ENVIRONMENT. Smith, D. G. (University

Coll. of North Wales, Bangor). Nucl. Instrum. Methods, 71: 137-40(1969).

The pulse height distribution of a channel multiplier has been measured at −78.5°C at pulse rates of 800/sec and 3,500-sec. The distributions were found to be broader and with lower modal values than at room temperature. In addition, the maximum integrated pulse current available from the multiplier was lower by a factor approximately 3.5 times greater than the increase in channel resistance. This result is interpreted in terms of a two-component model for the channel wall conductance. (auth)

**29275** POWER SUPPLY CHAINS FOR SAFETY AND WITH INCREASED DYNAMIC RANGE FOR PHOTOMULTIPLIERS. Looten, A. (CERN, Geneva). Nucl. Instrum. Methods, 71: 141-52(1969). (In French).

Two different types of power supply chains are described, one for the PM XP1110 and the other for the 56 AVP. Both comport circuits to eliminate discharge in the phototube under critical conditions, and parallel supply sources for the last dynodes. Their dynamic range is high enough to buffer power at the PM in all practical cases encountered in physics experiments. Variation of transit time in relation to charges flowing from the PM are measured comparativeiy between our chain and a standard resistive chain. (auth)

**29276** FLUX DISPLACERS FOR PULSE GENERATION WITH SUPERCONDUCTING MULTIPOLE MAGNETS. Thome, R. J.; Gaule, G. K. (Army Electronics Command, Fort Monmouth, N. J.). J. Appl. Phys., 40: 2140-6(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Short, steep pulses of high electrical energy are required to drive systems such as pulsed transmitters, light sources and plasma discharges. A low impedance stationary coil will generate such pulses when the magnetic flux threading the coil undergoes large and rapid changes. The rapid change can be achieved by a "flux displacer," a conductor driven at high speed past the stationary coil. The applied field is provided in the present work by a superconducting magnet in order to produce a magnetic flux of the necessary magnitude and density with small operating loss, bulk and weight. The stationary coil together with the load and the flux displacer were not superconducting and were placed outside the Dewar. Two series of experiments with flux displacers driven by a rotary prime mover are discussed. The first series used relatively small, isolated specimens. These experiments served to determine the effect of displacer shape, speed and conductivity on output. The second series used relatively large displacers formed by pairs of cylindrical shell segments which are electrically and mechanically connected by end plates. These experiments give information on the influence of various system parameters on the energy, and on the duration and shape of the pulses. The results are presented in dimensionless form, so that the performance of higher-energy systems can be predicted. Ultimately, the rotary prime mover may be a lightweight explosive drive or gas turbine or, in a vehicle or aircraft, one of the propulsion engines. (auth)

**29277** FREQUENCY AND TIME DOMAIN ANALYSIS OF A SUPERCONDUCTIVE COAXIAL LINE USING THE BCS THEORY. McCaa, W. D. Jr.; Nahman, N. S. (National Bureau of Standards, Boulder, Colo.). J. Appl. Phys., 40: 2098-2100(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

A miniature superconductive lead/teflon/niobium coaxial line has been analyzed in terms of the complete BCS theory of superconductivity. The surface impedance of both superconductors, the line attenuation, and the picosecond step responses have been calculated for a temperature of 4.24°K. The dielectric has been assumed lossless. In addition, the frequency and time domain responses obtained with the BCS theory are compared with those predicted in 1968 by McCaa and Nahman for the same line parameters by the two fluid model. (auth)

**29278** USE OF A SUPERCONDUCTING MODULATOR IN A VOLTMETER WITH $10^{-12}$ V RESOLUTION. Erdman, Robert J. (Keithley Instruments, Inc., Cleveland). J. Appl. Phys., 40: 2086-90(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Various methods of measuring low dc voltages at cryogenic temperatures have been used for purposes of investigating thermoelectric properties, resistive dependence on various parameters, superconducting phenomena, and other effects. These generally involve resolution on the order of $10^{-10}$ V or less and source resistances on the order of $10^{-6}$ Ω or less. A voltmeter suitable for this type of work is described. The instrument employs a superconducting parametric amplifier modulator described by Ries and Satterthwaite as a null sensing element in a feedback system. The modulator consists of a tuning fork which creates a time-varying mutual inductance between 2 sets of superconducting coils. The system equations and experimental data indicate that for low source resistance the accuracy and time constant of the voltmeter are essentially independent of source resistance. The noise is less than $10^{-12}$ V and the time constant is about 1.5 sec for source resistances of zero to $3 \times 10^{-7}$ Ω. The modulator is well suited for production, and is quite insensitive to operating temperature and vibration. The voltmeter has reliability and repeatability typical of commercial room-temperature instrumentation. (auth)

**29279** SUPERCONDUCTING ANTENNAS. Walker, G. B. (Univ. of Oklahoma, Norman); Haden, C. R. J. Appl. Phys., 40: 2035-9(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

A high-efficiency electrically and physically small superconducting antenna is reported. Antenna factors and matching circuit equivalents are developed. Theoretical predictions of efficiency and Q increase are derived on the basis of the superconducting surface resistance of lead. The antenna is a loop suspended through a ground plane and matched through a symmetrical coaxial cavity having a resonant frequency of 400 MHz. The loop is lead-plated and has an open area of approximately 1 $cm^2$. Coupling to the system is achieved through a movable electric-field probe inserted into a slot in the wall of the matching cavity. A normal-state electrically small antenna of this size has a theoretical efficiency of less than 1% due to the fact that the loop resistance is much larger than the equivalent radiation resistance. Upon cooling to 4.2°K, the Q of the system increases to 20,000 from a room-temperature value of 156, indicating limitation by the radiation resistance only. The power radiation efficiency increases by a factor of 500, as measured by a fixed external receiving system. The VSWR of the system is maintained near unity in order to avoid the complications of mismatching. (auth)

**29280** SLOW-WAVE STRUCTURES UTILIZING SUPERCONDUCTING THIN-FILM TRANSMISSION LINES. Mason, P. V.; Gould, R. W. (California Inst. of Tech., Pasadena). J. Appl. Phys., 40: 2039-51(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Slow-wave propagation of electromagnetic waves in transmission lines formed of thin-film superconductors has been studied theoretically and experimentally. Previous theoretical analyses have been extended to include nonlocal theories. Strong dependence of phase velocity is found on film thickness and interfilm spacing when these become less than a few penetration depths. Velocity is also modified by coherence length, mean free path, nature of reflection of electrons at the film surfaces, and by temperature and magnetic field. Experimental measurements were made to verify the dependence on thickness, spacing, and temperature by means of a resonance technique. Agreement with theory was excellent in the case of temperature. Data taken for varying thickness and spacing verified the general trend of theoretical predictions. They indicate a nonlocal behavior with some specular reflection, but scatter of the data taken for different films prevents precise comparison of theory and experiment. Estimates of bulk penetration depths were made for indium, $\lambda_{In} = 648 \pm 130$ Å. For tantalum a rough estimate could be made of $\lambda_{T_0} = 580$ Å. Data were consistent with the estimate of coherence length for indium of $\xi_0 \approx 3000$ Å. Velocity was found to be independent of frequency in the range 50 to 500 MHz, while losses increased as the square. Pulse measurements indicated that delays of several microseconds and storage of several thousand pulses on a single line are feasible. (auth)

**29281** AUTOMATIC TUNING OF A SUPERCONDUCTING CAVITY USING OPTICAL FEEDBACK. Stone, J. L.; Hartwig, W. H.; Baker, G. L. (Univ. of Texas, Austin). J. Appl. Phys., 40: 2015-20(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

The resonant frequency of a superconducting cavity has been photodielectrically controlled by a feedback loop which contains an optical path. The cavity is an 870-MHz lead-plated quarter-wave reentrant structure. A 19,000 Ω · cm silicon wafer terminates the quarter-wave stub. The loaded Q is approximately $10^5$ indicating the losses in the semiconductor dominate the superconducting surface resistance. The high Q provides a large phase error between the input and output voltage when the driving oscillator drifts or is modulated away from the very stable resonant frequency of the cavity. The error is processed by a wide-bandwidth phase detector that drives a gallium arsenide diode to follow the frequency excursion of the oscillator by photodielectric tuning. The 9000 Å

light is the optical feedback signal which corrects the phase error. The system response typically provides a frequency deviation of ±50 kHz at a 0.2 MHz rate. Higher cavity frequency and purer semiconductor samples extend the deviation limits and shorter free-carrier lifetimes increase the speed of response. (auth)

**29282** CONTINUOUS DIGITAL RATEMETER. Rudnick, S. J.; Michaud, P. L.; Porges, K. G. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 71: 196-200(1969).

A continuously-reading linear digital ratemeter has been designed. The unit is logically simple and has an easily analyzed square rather than exponential memory characteristic. The resolving time, statistical fluctuations, and response time of the proposed instrument are calculated and comparisons are made to previous digital ratemeter designs. A delayed replica of the input pulse train, which is useful for those applications which require anticipatory recording, is a by-product of the circuit. The basic unit can be readily extended to indicate differential as well as integral count rate. (auth)

**29283** FAST BURST REACTOR ON-LINE MASS SEPARATOR. Forman, L. (Aberdeen Research and Development Center, Aberdeen Proving Ground, Md.). Nucl. Instrum. Methods, 71: 170-2(1969).

An on-line separator has been constructed for use with a fast burst reactor, to determine the independent yield and nuclidic mass of some short-lived fission products. (auth)

**29284** PARTICLE-SIZE SPECTROMETRY OF AEROSOLS BY LIGHT SCATTERING IN A LASER BEAM AND ITS APPLICATION TO AIR MONITORING AND FILTER TESTING. Jacobi, W. (Hahn-Meitner Institut fuer Kernforschung, Berlin). pp 33-42 of Treatment of Airborne Radioactive Wastes, Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

A new type of a particle-size spectrometer for aerosols was developed using a low-power He-Ne laser as light source. The light scattered from single particles crossing the laser beam is measured in nearly $4\pi$-geometry by a suitable light conductor which is connected to the cathode of a photomultiplier. The multiplier pulse is transformed by a special pulse forming and integrating circuit whose output signal is proportional to the area of the original light pulse and can be fed into a standard multichannel analyzer. As no optical lens systems are used, the design of the instrument is rather simple and a low background of undesired, scattered light can be reached. The spectrometer was calibrated with monodisperse latex aerosols of different size. The lowest detectable particle diameter of the first working model was 0.3 $\mu$m. The spectrometer is distinguished by its good size resolution of 5 to 15%, depending on particle size, and its small scattering volume of only 0.05 mm$^3$. This permits the direct spectrometry of aerosols with concentrations up to a few 1000 particles/cm$^3$ without dilution. The instrument was developed especially for air monitoring in normal, unfiltered air, for measurements of filter efficiency versus particle size, and for studies on coagulation and inhalation of aerosols. Some of these applications are discussed. (auth)

**29285** AN AUTOMATIC MONITOR FOR ALL FORMS OF AIRBORNE RADIOIODINE. Holford, R. M. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). pp 7-17 of Treatment of Airborne Radioactive Wastes, Vienna, International Atomic Energy Agency, 1968.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York. See STI/PUB-195; CONF-680811.

One of the main problems encountered in monitoring air near a reactor for radioiodine is that an appreciable, though variable, proportion of the activity is associated with organic forms of iodine such as methyl iodide. Charcoal-loaded filter papers, such as Whatman ACG/B, do not retain this form of iodine for any appreciable time, although their efficiency for iodine in the elemental form is very high; and therefore in the past they have not been considered suitable for many applications in health physics. We have discovered, however, that the addition of a few parts per million of elemental bromine to the incoming air stream overcomes this difficulty and enables the paper to extract both elemental iodine and methyl iodide from air with high efficiency. This has been established directly by laboratory experiments and indirectly on a prototype of the instrument under working conditions. In our instrument ACG/B paper is used in the form of a roll so that the area of filter in use can be changed automatically at suitable intervals. The activity on the area in use is monitored continuously by a single-channel scintillometer, giving an output which is proportional to the cumulative exposure to radioiodine since the last change of paper. The output is displayed on a recorder with a linear scale which is switched automatically over six ranges. This is used in preference to a single logarithmic scale because the concentration of radioiodine in the air can more easily be estimated from the rate of increase of the count rate on a linear scale. (auth)

**29286** DISPOSABLE AERATOR FOR RADIOACTIVE HYDROPONIC CULTURE. Wieland, P. A. T.; Romney, E. M. (Univ. of California, Los Angeles). Contract AT(04-1)Gen-12. Soil Sci. Soc. Amer., Proc., 33: 325(Mar.-Apr. 1969).

An aerator for use with radioactive hydroponic media can be constructed with hypodermic needles and rubber or plastic tubing. The system described is inexpensive and adaptable to fit almost any size or configuration of an experiment. It can be disposed of easily in accordance with laboratory health and safety regulations. (auth)

**29287** WELDING FINE WIRES. Bellezza, Michele (to EURATOM). British Patent 1,152,717. May 21, 1965. Priority date June 16, 1965, Italy.

An apparatus is described for making welds between fine wires and specifically irradiated wires, such as thermocouple wires inside a radiation shield, in cases where for safety reasons the operator is remote from and protected from such wires. (B.G.D.)

## Radiation Effects on Instruments and Instrument Components

**29288** (N-69-21150) ACTION OF LITHIUM IN RADIATION-HARDENED SILICON SOLAR CELLS. Quarterly Report, October 16, 1968-January 15, 1969. Brucker, G. J.; Faith, T. J.; Holmes-Siedle, A. G. (Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.). Feb. 15, 1969. Contracts NAS7-100; JPL-952249. 35p. (NASA-CR-100453; AED-R-3426). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

The test vehicles being used for this work were (1) small-area solar-cell devices, (2) a group of solar cells, (3) solar cells, and (4) silicon bars, usually in the Hall-bar configuration. The source of particle irradiation used was a 1-MeV electron beam. The physical properties and photovoltaic performance of a large number of cells were measured before irradiation and after recent irradiation to fluences of $1 \times 10^{14}$, $5 \times 10^{14}$, or $3 \times 10^{15}$ e/cm$^2$. A total of thirty-two crucible-grown cells, irradiated to $1 \times 10^{14}$ e/cm$^2$, suffered no redegradation in a period extending to 69 days after irradiation. All except five cells showed significant recovery, one group of five having higher power than n/p control cells irradiated to the same level. Float-Zone, Quartz-Crucible, and Lopex cells irradiated showed no redegradation in short-circuit current over a period extending to 11 days after irradiation. Some cells irradiated to $3 \times 10^{15}$ e/cm$^2$, however, developed shunt leakages during irradiation or suffered increases in series resistance after irradiation. Measurements on five batches of Float-Zone cells with different lithium diffusion and redistribution schedules indicate a decrease in lithium density and increases in minority-carrier diffusion length and photovoltaic response with increasing redistribution time. (auth) (STAR)

**29289** (ORO-3651-3) RADIATION EFFECTS ON GERMANIUM. Annual Progress Report, June 1, 1968-May 31, 1969. Gossick, B. R. (Kentucky Univ., Lexington. Dept. of Physics and Astronomy). Feb. 1969. Contract AT(40-1)-3651. 51p. Dep. CFSTI.

I. Potential Difference Across Germanium Samples Generated by a Light Probe. Measurements of the potential difference generated across germanium samples by a light probe have been made; employing the interpretation of Riedl and Schoolar (1968) these measurements reveal the presence of bulk inhomogeneities and surface flaws. Survey measurements have also been made in an effort to observe the Dember effect. II. Haynes-Shockley Mobility of n-Type Germanium Bombarded by Fast Neutrons. Measurements of the Haynes-Shockley ambipolar carrier mobility against temperature in n-type germanium have been made before and after bombardment by fast neutrons. Preliminary results after bombardment with integrated flux of $10^{12}$ fast neutrons cm$^{-2}$ on a 5 ohm-cm and 20 ohm-cm resistivity sample show that mobility increases as observed by Closser at room temperature, but observations near liquid nitrogen temperature reveal that the mobility in the 5 ohm-cm sample decreases while the mobility in the 20 ohm-cm sample increases initially with bombardment. Changes after bombardment in resistivity support the disordered region model; changes in the mobility of holes suggest that some holes are being trapped by disordered regions. III. Method of Determining the Ambipolar Diffusion Coefficient in Semiconductors, and the Excess Carrier Concentration at a Metal-Semiconductor Boundary. A method of

determining the ambipolar diffusion coefficient by measuring the ambipolar diffusion length and the effective recombination time is described. The sample is exposed to collimated chopped light while carrying an rf current. Advantages of the method include: a reduction in the shunting effect of the capacitance of leads to the sample entering and leaving the cryostat by incorporating the capacitances in tuned circuits, and the dependence on a quantity, the ambipolar diffusion coefficient, which is a maximum instead of the ambipolar mobility, which is a minimum with pure material. It is also shown how to use the same experimental arrangement to measure the excess carrier concentration at a metal–semiconductor ohmic contact. (auth)

**29290** (SC-DC-68-2556) IONIZING RADIATION EFFECTS IN MOS DEVICES. Gwyn, C. W. (Sandia Labs., Albuquerque, N. Mex.). [1967]. 6p. (CONF-690506-1). Dep. CFSTI.

From 135th National Meeting of the Electrochemical Society, New York.

The effects of ionizing radiation on the oxide layers of MOS devices are discussed. A broken bond model is used to explain charge trapping in the oxide layer. For this model, it is assumed that defect or trapping centers are produced by the valence bond localization on the silicon and oxygen atoms when an electron is removed from a strained silicon oxygen bond by ionizing radiation. (B.G.D.)

# LIFE SCIENCES

## Biochemistry, Physiology, and Molecular Biology

*Refer also to abstract 29286.*

**29291** THE DEPOSITION OF AEROSOL PARTICLES OF DIFFERENT SIZES IN REGIONS OF THE HUMAN RESPIRATORY TRACT: A NEW EXPERIMENTAL APPROACH. Przyborowski, S. (Radiation Protection Center, Berlin). Ann. Occup. Hyg., 12: 27-32(Jan. 1969).

A combined experimental–mathematical approach for the determination of aerosol deposition in the various regions of the human respiratory tract is described. The intervals of the partial expired volumes were continuously variable. Breathing frequency was signalized acoustically and the inspired volume as well as the partial expired volumes were recorded. The particle size distributions were measured simultaneously in 10 particle size intervals. By means of the given formulas aerosol deposition in the various regions of the respiratory tract could be calculated from the particle size distributions measured for the inspired volume and the partial expired volumes. (UK)

### Basic Processes

*Refer also to abstract 28675, 28727, 28729, 28730, 28743, 28754, 29075, 29184, 29581, 29601, 29629, 29652, and 29784.*

**29292** (BNWL-SA-2281) HYBRID METHOD FOR RESOLUTION OF ULTRACENTRIFUGE DATA. Cole, Charles R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 9, 1969. Contract AT(45-1)-1830. 10p. (CONF-690106-1). Dep. CFSTI.

From Northwest Simulation Council Meeting, Portland, Ore.

A computerized method for qualitative and quantitative analysis of ultracentrifuge data on macromolecular concentrations from plots of counts of radioactivity per fraction versus the gradient layer (fraction number) is presented. The experimental method is briefly described. The curve fitting technique solves an 18 parameter optimization problem using semi-automatic methods. The 3,000 iterative solutions required to fit one curve are generated by a hybrid computer in 5 minutes. Automatic optimization techniques can be developed to reduce the amount of computer time required. The automated method would also be more directly available to cell biologists. (H.G.D.)

**29293** (CEA-R-3240) RADIOACTIVE COLLOIDS IN THE FUNCTIONAL EXPLORATION OF THE RETICULO-ENDOTHELIUM SYSTEM. Chivot, Jean-Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 1967. 150p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, France.

A historical review describes the reticulo-endothelial system (R.E.S.) and aims at defining it and at explaining its operation. The methods used for its examination and the colloids utilized are considered. An albumin complex containing radioiodine, C.A. $^{131}I$, and its method of preparation and physical and biological examination are described. This atoxic and metabolisable preparation of biological origin is compared with the better-defined colloidal gold which serves as reference. Following injection of C.A. $^{131}I$ into mice, it is shown by radioactivity measurements, autoradiographies on sections of the whole animal, and anthropogammetric detections that a high concentration occurs in the R.E.S. of the liver. These static results are only of limited importance however compared to those obtained from an in vivo study of the phenomenon. Changes in the radioactivity of the blood derived from the carotid artery are recorded with a well-scintillator. A curve of blood radioactivity had a decreasing exponential form that is described mathematically. The biological half-life of the colloid in the blood is a measure of its phagocytosis by the R.E.S. cells. A supplementary check is provided by the direct recording of the hepatic activity using a suitably collimated exterior detector. A curve of increasing-exponential form is obtained and its parameters are corollary to the preceding curve. These tests carried out on guinea-pigs and rats make it possible to give to the R.E.S. a phagocytic index which is characteristic of its state of activity. The phagocytic index K depends also on the diameter of the colloidal particles injected and can be used as biological test for a colloid; this is the percentage of injected colloid which is retained by the R.E.S. per unit time. Numerous tables, graphs, diagrams and photos are presented. (C.O.)

**29294** (CONF-670649-20) SOME APPLICATIONS OF RADIOBIOLOGY IN THE INVESTIGATION OF ANIMAL REPRODUCTION PHENOMENA. Perez Garcia, Tomas; Cuellar Carrasco, Leopoldo (Junta de Energia Nuclear, Madrid (Spain)). [1966]. 10p. (In Spanish). Dep.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

Some ideas concerning the possibilities of using radiobiology in the field of animal reproduction are summarized. The concepts presented necessitate a revision of the investigative principles for the use of radioisotopes as tracers and of the effects of ionizing radiation on the idiotype of the individuals and on the reproduction phenomena. The use of radioisotopes as tracers in exact determination of the duration of the different phases of gametogenesis is discussed. The effects of radiation on gonads, gametes, and embryos were studied and possible applications of radiation in zoology are discussed. (C.O.)

**29295** (CONF-670649-28) COLLOIDAL RADIOPHARMACEUTICALS. Angoso Marina, Manuel (Junta de Energia Nuclear, Madrid (Spain)). [1966]. 12p. (In Spanish). Dep.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

In the course of the last few years, a series of radioactive colloids were prepared with special precautions with respect to their bulk, stability, specific activities, and other factors. The first preparation was that of colloidal $^{198}Au$ in the metallic state. The Henry method was followed and a method was developed for the determination of the size of the grain. The convenience of pure $\beta$ emitters led to the preparation of a colloidal chromium phosphate labeled with $^{32}P$ by a precipitation method, which simplified the method of precipitation and calcination. A colloidal zirconyl phosphate labeled with $^{32}P$ was prepared by precipitation, and this colloid has the advantage of being much more soluble than the chromium phosphate. Colloidal yttrium silicate, labeled with $^{90}Y$ was also prepared. (tr-auth)

**29296** (RISO-192) PREPARATION OF $^{131}I$-LABELLED PROTEINS BY AN ELECTROLYTICAL METHOD AND PURIFICATION OF THE LABELLED PRODUCT. Khalkhali, Zhila; Jacobsen, Ulf (Danish Atomic Energy Commission, Risoe. Research Establishment). Dec. 1968. 33p. Dep.

The aim was to establish a simple and reliable method for iodine labeling of different proteins and purification of the labeled products to the extent where they can be used for metabolic investigations. The preparation of iodine-labeled, high-specific-activity proteins by an electrolytical method is reported. Human serum albumin was selected as a model substance for preliminary experiments to find the optimum condition for labeling. Different proteins were iodinated to a mean level of 0.1 to 0.5 atom per molecule of protein; a labeling yield of ~90% was achieved in most cases. Investigations were also made covering the purification of the labeled product immediately after the preparation by gel filtration. Metabolic studies and pyrogenicity tests carried out on the labeled and purified rabbit serum albumin and transferrin demonstrated that the products are pyrogene free and metabolized as the genuine proteins. (Denmark)

**29297** (UCRL-18832) QUANTITATION OF CERTAIN ALTERATIONS IN INTERMEDIARY METABOLISM IN VIVO ASSOCIATED WITH CHANGES IN BODY CONTENT OF VITAMINS B1, B6, B12, AND FOLIC ACID USING $^{14}CO_2$ BREATH ANALYSIS. Ngo, Tran Manh (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1969. 173p. Dep. CFSTI.

Thesis.

Information on biochemical actions of soluble B vitamins upon metabolic pathways is derived primarily from studies on either single-cell organisms or cell-free systems. Little information is available for higher animals concerning quantitative aspects of biochemical actions of excess or deficient soluble B vitamins on metabolic pathways. $^{14}CO_2$ breath analysis appears to be a powerful technique for the study of the biochemical processes in vivo. Measurement of the rate of $^{14}CO_2$ excretion in the breath permits some estimation of cell-membrane transport of the $^{14}C$-labeled materials ($^{14}C$-R) and metabolic processes involved in the handling of $^{14}C$-R. In addition, this technique allows for evaluation of the effects of physiological and pharmacological doses of a variety of materials such as the B vitamins. An example of the study of cell-membrane transport of amino acids was the determination of the competitive effect of L-methionine on L-histidine or L-serine transport across the cell membrane. In the work presented here, decreased $^{14}CO_2$ production but a normally shaped curve was noted in the breath of L-methionine-treated rats subsequent to the in-

travenous administration of L-histidine (imidazole-2-$^{14}C$) and L-serine-3-$^{14}C$. Administration of pharmacological doses of pyridoxine resulted in decreased $^{14}CO_2$ excretion in the breath and a delayed $T_{max}$ in normal rats given pyridoxine prior to the intravenous injection of L-tryptophane-I-$^{14}C$. This result was felt to arise from hypertrophy of the intracellular L-tryptophane pool subsequent to its enhanced cell-membrane transport by pyridoxine. An example of the study of alterations in intermediary metabolism of certain $^{14}C$-labeled materials by changes in body content of soluble B vitamins was the analysis of thiamine deficiency in rats. There was a significant delay in $^{14}CO_2$ excretion in the breath of thiamine-deficient rats subsequent to the intravenous administration of pyruvate-I-$^{14}C$ and acetate-I-$^{14}C$, which was normalized within 45 minutes after the administration of thiamine. Similar results were obtained in irradiated rats after the administration of labeled monocarbon pool precursors, which suggested radiation inactivation of tetrahydrofolic acid or the processes responsible for its production. We may suggest that $^{14}CO_2$ breath analysis might be a sensitive method for assay of in vivo biochemical activity of large doses of soluble B vitamins in higher animals. One example of this type of study was the demonstration of increased $^{14}CO_2$ production after the injection of L-histidine (imidazole-2-$^{14}C$) in normal rats treated with pharmacological doses of cyanocobalamin and decreased $^{14}CO_2$ excretion in normal rats given pharmacological doses of folic acid. (auth)

**29298** (UCRL-50559) RADIATION EFFECTS ON POLY-dAT FROM INTRAMOLECULAR TRITIUM. Mazrimas, J. A.; Hatch, F. T.; Bishop, C. C.; Gill, J. E. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 6, 1968. 30p. Dep. CFSTI.

Poly-dAT (a polymer of alternating deoxyadenylic and deoxythymidylic residues) was biosynthesized from tritiated deoxythymidine-5'-triphosphate of high specific activity and deoxyadenosine-5'-triphosphate. Aqueous solutions were stored at −20°C and thawed at intervals for comparison of template activity, ultraviolet absorbance and thermal transition with that of unlabeled poly-dAT. The $^3H$ content of the two samples was $1.5 \times 10^8$ and $4.4 \times 10^8$ dpm/mg. Radiation doses were estimated to be 2.9 and 8.6 rad/day (300 and 1000 rad over 3 months), respectively, assuming uniform distribution of absorbed energy in the solution. The normally excellent template activity of poly-dAT for RNA and DNA polymerases from Escherichia coli progressively decreased. The impairment became measurable after a dose of only 20–50 rad. After three months there was a moderate increase in molar ultraviolet absorbance at 260 nm and a marked increase in the absorbance ratios at 230/260 and 290/260 nm. There was a small decrease in molar absorbance at 260 nm after heat denaturation, and calculations from the ultraviolet spectra indicated a marked decrease in the content of deoxyadenylic and deoxythymidylic residues. There was no change in the midpoint of the thermal transition, although its width gradually increased from 0.9 to 1.5°C in the irradiated samples. The magnitude of the transition at 260 nm was only 20 percent in both radioactive samples in contrast to 51 percent in the control. Dual isotope experiments in which $\gamma$-$\gamma$-$^{32}P$-ATP and $^{14}C$-ATP precursors were incorporated into polynucleotide in the presence of irradiated and control dAT templates suggest that the molecules synthesized in the presence of irradiated template were shorter than normal. The tritium radiation appears to cause major structural disruption of poly-dAT with alteration or destruction of many bases, and probable unstacking of others. (auth)

**29299** THE KINETICS OF NEUTROPHILIC GRANULOCYTES IN CHRONIC MYELOCYTIC LEUKEMIA: A REVIEW. Athens, John Wm.; Bishop, Carter R.; Cartwright, G. E. (Univ. of Utah, Salt Lake City). pp 219-28 of Proceedings of the International Conference on Leukemia-Lymphoma, Ann Arbor, Michigan, October 9–13, 1967. Zarafonetis, Chris J. D. (ed.). Philadelphia, Lea and Febiger, 1968.

See CONF-671073.

Tracer studies of neutrophilic granulocyte kinetics in patients with chronic myelocytic leukemia reviewed here, were begun with the hope that granulocyte kinetic parameters could be measured in this disease in the manner used in normal subjects and in patients with simple neutrophilia. However, it is evident from the results obtained to date that assessing the kinetics of myeloid cells in chronic myelocytic leukemia is complicated by the fact that they are apparently synthesizing DNA and undergoing cell division in the blood and tissues as well as the marrow; that the immature forms do not enter inflammatory lesions readily if at all; and that there may be sequestration of cells in the tissues with recycling back into the blood. Furthermore, it seems that the kinetic abnormalities seen in chronic myelogenous leukemia are not characteristic of this disorder only, but may be seen in any disorder in which immature myeloid cells are present in the blood and some as yet undefined extracorpuscular factor (perhaps splenic sequestration) is also present. (auth)

**29300** SOME DATA ON PRACTICE OF ELECTRON MICROSCOPIC AUTORADIOGRAPHY. Weber, H. (Institut fuer Mikrobiologie und Experimentelle Therapie, Jena, Ger.). Acta Biol. Med. Ger., 22: 159-67(1969). (In German).

To enhance reproducibility and to get more exact interpretation in electron microscopic autoradiography, series of ultrathin sections of a $^3H$-thymidine labeled mutant from E. coli CR 34 (λ) were used. Misinterpretations of apparent, accidental labels hereby may be considered reduced. It is possible to determine the spatial localization of the labeled source, also in non-spherical specimen. The tightly packed developed non-filamentous silver grains support the suggestion of previous reports that in a single crystal of silver bromide several latent images may be formed independently and expressed as separated centers of development. This seems to be important for sensitivity of the method. (auth)

**29301** EARLY DETECTION OF BACTERIAL GROWTH, WITH $^{14}C$-LABELED GLUCOSE. DeLand, Frank H.; Wagner, Henry N. Jr. (Johns Hopkins Medical Institution, Baltimore). Radiology, 92: 154-5(Jan. 1969).

A method is described for the early detection of bacterial growth in blood cultures. The sample was incubated in liquid media in which $^{14}C$-glucose was the sole source of carbohydrate. The evolution of $^{14}CO_2$ was the index of bacterial growth. (C.H.)

**29302** STUDIES ON THE ORIGIN OF RIBOSOMES IN AMOEBA PROTEUS. Craig, Nessly; Goldstein, Lester (Univ. of Pennsylvania, Philadelphia). J. Cell Biol., 40: 622-32(Mar. 1969).

The origin of cytoplasmic RNA and ribosomes was studied in Amoeba proteus by transplantation of a radioactive nucleus into an unlabeled cell followed by examination of the cytoplasm of the recipient for the presence of label. When a RNA-labeled nucleus was used, label appeared in the ribosomes, ribosomal RNA and soluble RNA. Since the kinetics of appearance of labeled RNA indicates that the nucleus was not injured during the transfer, and since the transferred nuclear pool of labeled acid-soluble RNA precursors is inadequate to account for the amount of cytoplasmic RNA label, it is concluded that cytoplasmic ribosomal RNA is derived from acid-insoluble nuclear RNA and is probably transported as an intact molecule. Likewise, cytoplasmic soluble RNA probably originated in the nucleus, although labeling by terminal exchange in the cytoplasm is also possible. The results were completely different when a protein-labeled nucleus was grafted into an unlabeled host. In this case, label was found only in soluble proteins in the host cell cytoplasm, and there were no (or very few) radioactive ribosomes. This suggests that the nuclear pool of ribosomal protein and ribosomal protein precursors is relatively small and perhaps nonexistent (and, furthermore, shows that there was no cytoplasmic ribosomal contamination of the transferred nucleus. (auth)

**29303** STUDIES ON THE WATER CONTENT OF VACCINIA VIRUS AND ITS HEMAGGLUTININ BY DENSITY GRADIENT CENTRIFUGATION. COMMUNICATION I. THE WATER CONTENT OF VACCINIA VIRUS. Schiek, Wolfgang (Univ., Goettingen, Ger.). Zentralbl. Bakteriol. Parasitenk., Abt. I Orig., 208: 351-63(Nov. 1968). (In German).

The buoyant density of fluorocarbon-purified and biologically intact vaccinia virus was determined in density gradient systems of sucrose, CsCl, and RbCl in light water ($H_2O$) as well as in heavy water ($D_2O$). For density determinations in light water gradients, virus suspended in $H_2O$ was used; for density estimations in heavy water gradients, virus suspended in $D_2O$ was used. The test could not be performed in the analytical ultracentrifuge, since vaccinia virus tends to aggregate at the high concentrations necessary for optical demonstration. The density of the virus was 1.237 g/cm$^3$ in sucrose-$H_2O$, 1.279 g/cm$^3$ in CsCl-$H_2O$, and 1.272 g/cm$^3$ in RbCl-$H_2O$. In the corresponding $D_2O$ gradients the density of the virus was higher. It amounted to 1.278 g/cm$^3$, 1.316 g/cm$^3$, and 1.303 g/cm$^3$ in the three $D_2O$ media. According to the differences in density, the $D_2O$ interchangeable water content could be calculated. It was up to 38% in the sucrose system (mean molarity at the point of balance of the virus in the gradient = 1.7 M), to 34% in the CsCl-system (M = 2.0), and to 29% in the RbCl-system (M = 2.8). The water content and the density of the virus particle suspended in pure water were calculated by extrapolation, yielding values of 52% and 1.178 g/cm$^3$. Both values are in accord with those in the literature. (BBB)

**29304** SENSITIVITY OF RADIOISOTOPE TECHNIQUES FOR THE ASSAY OF BOVINE SERUM ALBUMIN AND OF ANTI-BOVINE SERUM ALBUMIN ANTIBODIES. Sulitzeanu, D.; Rasooly,

G.; Lawinstein, R. (Hebrew Univ., Jerusalem). Israel J. Med. Sci., 5: 274-7(Mar.-Apr. 1969).

Detailed directions are given for the radioimmunoassay of BSA (bovine serum albumin) and for the assay of mouse anti-BSA antibodies using iodine-125. Standard curves for both tests are presented. (C.O.)

**29305** ASHING PROCEDURES FOR BIOMATERIAL. Doshi, G. R.; Sreekumaran, C.; Mulay, C. D.; Patel, B. (Bhabha Atomic Research Centre, Bombay). Curr. Sci. (India), 38: 206-8(May 5, 1969).

An attempt was made to study the loss of trace elements incorporated in biological systems. Radiotracers were injected into the living system, tissues removed and counted, and the loss of trace elements during ashing procedure determined. Percentage recoveries of various isotopes under different oxidizing and ashing conditions are presented in tabular form. The use of a $HNO_3$-$H_2O_2$ mixture, or, where dry ashing is essential, heating at 450° is recommended. (C.O.)

**29306** FIELD TRIALS ON RADIOISOTOPE TAGGING OF TICKS. Sonenshine, Daniel E. (Old Dominion Coll., Norfolk, Va.); Clark, Gordon M. J. Med. Entomol., 5: 229-35(June 10, 1968).

Methods for labeling ticks with $^{14}C$ were developed and tested in the field. Radioisotope-tagged larvae of Dermacentor variabilis and D. andersoni were obtained by collecting the progeny of engorged females inoculated with $^{14}C$-glucose or -glycine. The isotope was inoculated through the body wall of the tick with a 50-$\mu$l syringe and 30-gauge needle or with a glass capillary inserted into capillary tubing and micrometer drive syringe. Eggs from treated ticks were collected, allowed to hatch, and checked for radioactivity as described. The advantage of this method over external labeling techniques is that radioactivity of reared larval ticks may be regarded as relatively permanent for that stage. Field trials demonstrated that radioisotope-tagged larvae released into habitats of appropriate host animals may be recaptured in large numbers. Further, the recapture of substantial numbers of overwinter survivors of the original release indicated that this technique may be used in long-term studies. The feasibility of preparing large release populations in which a high percentage of individuals may be readily identified is also shown. (BBB)

**29307** MICRO RADIOMETRIC METHOD FOR STUDY OF ACID-INSOLUBLE MATERIALS IN MONOLAYER CELL CULTURES. Ziegler, Donald W.; Hutchinson, Harriet D.; Palmer, Erskine L. (National Communicable Disease Center, Atlanta). Appl. Microbiol., 17: 34-40(Jan. 1969).

A simple radiometric procedure for study of acid-insoluble products synthesized in monolayer cell cultures is described. Cell cultures were produced directly on the bottom surface of scintillation vials or on glass cover slips (8 × 30 mm). The cells were labeled and extracted; the radioactivity was determined while the cells remained affixed to the glass surface upon which they were grown. This procedure enabled rapid investigations of certain biosynthetic processes to be carried out by using many individual cell cultures. The method was applied to an investigation of $^3H$-thymidine incorporation induced by vaccinia virus in a 5-bromodeoxyuridine-resistant cell line. $^{14}C$-labeling was evaluated as an alternate procedure for cell quantitation. (auth)

**29308** VACCINIA NEUTRALIZATION TEST USING A RADIOISOTOPE ASSAY FOR VIRUS-INDUCED ENZYME ACTIVITY. Ziegler, Donald W.; Hutchinson, Harriet D. (National Communicable Disease Center, Atlanta). Appl. Microbiol., 17: 41-7(Jan. 1969).

Vaccinia virus induction of a metabolic activity in host cell cultures forms the basis of a new assay for neutralizing antibodies. A direct relationship between the amount of vaccinia virus infecting cell cultures and the induced incorporation of tritium-labeled thymidine into the acid-insoluble fraction of the cells provided an indicator system. A liquid scintillation spectrometer was used to determine radioactivity associated with cell materials, and it provided a method for partial automation of an immunological procedure. Reproducibility of the method was satisfactory, and agreement with conventional vaccinia serum neutralization tests was demonstrated.

## *Metabolism, Physiology, and Toxicology*

*Refer also to abstracts 29182, 29183, 29344, 29377, 29419, 29432, 29476–29482, 29486–29488, 29490, 29491, 29569, 29609, 29611, 29612, 29790, 29855, and 29894.*

**29309** (ACRH-30, pp 49-57) HUMAN TOTAL-BODY RETENTION AND EXCRETORY ROUTES OF $^{75}Se$ FROM SELENOMETHIONINE. Lathrop, K. A.; Harper, P. V.; Malkinson, F. D. (Argonne Cancer Research Hospital, Chicago, Ill.).

Observations were made on the total-body retention and the renal, intestinal, and pulmonary excretion of $^{75}Se$ after its intravenous administration as $^{75}Se$-labeled methionine. Other excretory routes, such as hair, fingernails, and psoriasis scales, were examined for $^{75}Se$. These studies indicated that after a single injection of $^{75}Se$-labeled methionine, one-half of the $^{75}Se$ was eliminated from the body at about 80 days. The retention curve had three components: the first had a half-time of approximately 6.8 days for about 8% of the injected $^{75}Se$; the second, 73 days for 64%; and the third, 325 days for 28%. The absorbed radiation dose to the whole body for complete decay of 220 $\mu$Ci in a 70 kg man was calculated to be around 1.65 rad for the $\gamma$ component and 0.38 rad from the $\beta$-like radiation. Small losses of $^{75}Se$ occurring via the breath, hair, nails, and skin probably accounted for less than 5% of the injected radioactivity. Probably around 80% of the injected $^{75}Se$ left the body in the urine; the remainder of the dose was contained in the feces. (C.O.)

**29310** (AEEW-M-800) FOLLOW UP STUDIES OF A CASE OF INTERNAL CONTAMINATION WITH RADIOACTIVE DUST. Speight, R. G. (Atomic Energy Establishment, Winfrith (England)). Aug. 1968. 14p. Dep. CFSTI. UK.

The case history of a patient who had been accidentally exposed to a mixture of radionuclides is described. Whole-body counting was repeated at intervals throughout one year, and the observed gamma ray spectra were subjected to computer analysis. Estimates for the biological half lives of metabolized zinc and cesium for this individual are 220 days and 70 days, respectively. (UK)

**29311** (COO-1495-9) MOVEMENT OF STRONTIUM THROUGH THE SOIL TO PLANT ROOT MEMBRANE. Technical Progress Report, June 1, 1968–May 31, 1969. ([Purdue Research Foundation, Lafayette, Ind.]). Contract AT(11-1)-1495. 37p. Dep. CFSTI.

Mechanisms involved in the uptake of Sr from soil by plant roots were studied. Results from experiments using several mineral soils and plant species showed more Sr and Ca were supplied to the plant root by mass flow than the plants could absorb. Data are presented on the content of Ca and Sr in soybeans (Glycine max) and wheat (Triticum aestivum) grown in organic and mineral soils. The effects of soil properties on the distribution and bonding of Sr in soil were also studied using $^{89}Sr$ as a tracer. (C.H.)

**29312** (COO-1630-10) THE METABOLISM OF RARE EARTHS FOLLOWING INHALATION: PATHOLOGIC AND BIOCHEMICAL RESPONSE IN THE LUNG AND OTHER ORGANS. Summary Report, June 16, 1966–June 15, 1969. Berke, Harry L. (Wayne State Univ., Detroit, Mich. Dept. of Occupational and Environmental Health). Mar. 15, 1969. Contract AT(11-1)-1630. 11p. Dep. CFSTI.

Brief summaries of research progress are presented for the following areas: The physical characterization of aerosols generated from solutions of selected rare earths and Group 3B elements (yttrium, scandium, cerium, europium, and ytterbium). The deposition and retention of inhaled particulates as related to aerosol particle size; lung clearance mechanisms; the organ and tissue distribution; the elimination route and its magnitude. The development of sensitive tests for tissue response to irradiation from external and/or internal sources for use in the diagnostic determination of effects at low levels of exposure. The biological response of the lung and other organs to retained material in terms of developing pathology and tumorigenesis, organ function, and possibly life-span shortening; the correlation of stable isotope burdens with observed deleterious response. Synergism or potentiation of the biological effects of the stable isotope by concurrent radioisotope inhalation. A title list of studies completed or in progress is given. (C.O.)

**29313** (COO-1630-11) THE METABOLISM OF RARE EARTHS FOLLOWING INHALATION: PATHOLOGIC AND BIOCHEMICAL RESPONSE IN THE LUNG AND OTHER ORGANS. Technical Progress Report, June 16, 1968–June 15, 1969. Berke, Harry L. (Wayne State Univ., Detroit, Mich. Dept. of Occupational and Environmental Health). Mar. 15, 1969. Contract AT(11-1)-1630. 17p. Dep. CFSTI.

Female Sprague–Dawley rats were subjected to exposures of aerosols (scandium chloride–$^{46}Sc$, yttrium chloride–$^{88}Yt$, cerium chloride–$^{144}Cr$, europium chloride–$^{152-154}Eu$, and ytterbium chloride–$^{169}Yb$) for a three-hour period and sacrificed at 3 and 24 hours and at spaced intervals thereafter for about 70 days. Tissues and organs including bone (femur and molars) were assayed. The whole skeleton was also dissected out and assayed as a check on previous calculations of skeletal burdens from femoral activity for europium. Excreta were collected separately

(urine, feces) for assay and whole-body counts were obtained in vivo for a number of animals during the post-exposure period. Pertinent data are presented in tabular form. (C.O.)

**29314** (UCRL-18347) BIOLOGY AND MEDICINE SEMI-ANNUAL REPORT. Lawrence, John H. (California Univ., Berkeley). Spring 1968. Contract W-7405-eng-48. 201p. Dep. CFSTI.

Separate abstracts were prepared on ten sections of this report. A list is included of 44 publications during the period covered. (C.H.)

*For abstracts of individual sections see: 29347, 29396, 29508, 29573, 29609–29611, 29743, 29825, and 30298.*

**29315** DYNAMICS OF THE ACCUMULATION OF HEAVY HYDROGEN IN THE AQUEOUS PHASE OF THE RABBIT ORGANISM AFTER PROLONGED ADMINISTRATION OF TRITIUM OXIDE. Chirkova, E. N.; Avtandilov, G. G. (Inst. of Human Morphology, Moscow). Radiobiologiya, 9: 228-31(1969). (In Russian).

In the case of prolonged daily administration of tritium oxide (0.005 mCi/g) to healthy rabbits, there is an exponential accumulation of tritium in the water of the urine and blood; moreover, in the aqueous phase of the blood the tritium concentration becomes 15% higher than in the urine by the time dynamic equilibrium is reached (by the 16th to 17th day). (auth)

**29316** WANNIER REACTION AND DETERMINATION OF CYTOTOXINS IN RATS AFTER THE ADMINISTRATION OF RADIOACTIVE SUBSTANCES. Shal'nova, G. A. (Inst. of Biophysics, Moscow). Radiobiologiya, 9: 266-70(1969). (In Russian).

Dynamic observation of the presence of autoantibodies (according to the Wannier reaction) and cytotoxins (leuko- and cytolysins) for periods up to 400 days after injection of the isotopes was conducted in the blood of rats treated with polonium-210 at a dose of 0.005 μCi/g (40 rats) and cerium-144 at a dose of 0.7 μCi/g (45 rats). A positive Wannier reaction was more frequently detected in rats after the administration of polonium (62.5%) in comparison with the experiment in which cerium was administered (38.5%). Among the control rats the Wannier reaction was negative. Leuko- and cytolysins were detected significantly more often among injured animals than in the control (62–82% of the cases among the experimental rats and 23–29% among the controls). (auth)

**29317** LONG TERM RETENTION OF RADIUM IN MAN. Rundo, J. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 221: 1059(Mar. 15, 1969).

Knowledge of the retention pattern is a fundamental requirement in relating the body content of radium at the time of observation of late biological effects, such as a bone neoplasm, to the amount of radium initially in the blood, but the accuracy of the estimated biological elimination rate for individuals is stated to be poor. In addition to its importance from the point of view of radiological protection, the late elimination rate of radium (or any alkaline earth) is of interest in the study of the physiology of bone, especially if data are available on the initial retention and plasma concentration. A study is described of measurements made since 1957 on a healthy man who was occupationally exposed to $^{226}Ra$ in 1940; it was found that a small body burden still remains. A biological half-life of 9.0 ± 1.8 yr was obtained. The early retention data for $^{223}Ra$ and the late retention data for $^{226}Ra$ in the same subject were consistent with the predictions of Marshall's theory (J. Theoret. Biol., 6: 386(1964)). (UK)

**29318** INVESTIGATION OF THE SENSITIVITY OF RATS TO THE β-RADIATION OF INCORPORATED $^{90}Sr$ AS A FUNCTION OF THE AGE AND SEX. Shvedov, V. D. (Inst. of Biophysics, Moscow). Radiobiologiya, 9: 325-7(1969). (In Russian).

The sensitivity of rats to strontium-90 at 45 days of age is substantially reduced, which was established on their $LD_{50}$. Under the influence of strontium-90 on the organism in larger concentrations ($LD_{50-5}$), the sexual differences in the radiosensitivity are eliminated. Increased resistance of females to strontium-90 was detected only by the establishment of $LD_{50-10}$. (auth)

**29319** UPTAKE OF COLLOIDAL THORIUM DIOXIDE BY MAST CELLS. Padawer, Jacques (Albert Einstein Coll. of Medicine, Bronx, N. Y.). J. Cell Biol., 40: 747-60(Mar. 1969).

Mast cells from the peritoneal cavity of the rat were obtained at various times following in situ injection of a colloidal thorium dioxide preparation (Thorotrast). They were prepared for electron microscopy by aldehyde fixation, osmium tetroxide postfixation, and embedding in Epon. Thorotrast was rapidly taken up by mast cells through enhanced or newly elicited surface specializations. It was confined at first to large vesicles that moved to the Golgi area. Subsequently, in a matter of a few hours only, it became associated with progressively more mature granules, including fully mature ones. In addition to demonstrating a further phagocytic or pinocytotic activity of mast cells, the findings suggest that mast cell granules share a common membranous investment, and that substances from the tissue environment may theoretically percolate over and interact with the granules. Mast cell function could thus be served primarily by absorptive rather than secretory processes. (auth)

**29320** EFFECTS OF LACTOSE ON THE UTILIZATION OF ALKALINE EARTHS, DETERMINED BY MEANS OF $^{85}Sr$, IN RATS OF DIFFERENT AGES, SEX, AND NUTRITIONAL FACTORS. Fournier, Paul; Fontaine, Nicole (CNRS, Paris). Compt. Rend., Ser. D, 268: 562-5(Jan. 20, 1969). (In French).

The metabolism of alkaline earths in rats varies greatly according to the age, sex, and the type of nutrition. In all cases the ingestion of lactose simultaneously with that of $^{85}Sr$ caused a great increase of the uptake of the $^{85}Sr$, measured by the increase of the radioactivity of the blood and the bone. (tr-auth)

**29321** STUDIES ON THE PRESENCE OF NATURAL THORIUM AND URANIUM IN A KIDNEY SURGICALLY REMOVED BECAUSE OF CLEAR-CELL CARCINOMA. Majewski, C.; Wszolek, B.; Kukiel, E.; Kubiak, E. (J. Strus Municipal Hospital, Poznan, Poland). Pol. Med. J., 7: 710-16(1968).

Translated from Patol. Pol., 18: No. 1, (1967).

In the course of studies on the etiopathogenesis of tumors, concentrations of natural thorium and uranium were determined in the healthy and paraneoplastic portions of a kidney surgically removed because of clear-cell carcinoma. The technique of nuclear plates was used. The experimental results revealed differences in concentrations of both thorium and uranium in three studied tissues. The highest concentrations of both radioelements were found in paraneoplastic tissue. Lowest concentrations were observed in tissues considered as normal. On the basis of an analysis of the results of thorium and uranium assays, and of the concentrations of both in paraneoplastic tissue it was suggested that accumulation of this type of element in the paraneoplastic tissue indicates intensification of unknown processes. (auth)

**29322** BODY BURDEN AFTER INHALATION OF RADON, THORON, AND THEIR DECAY PRODUCTS. Pohl, Egon; Pohl-Rueling, Johanna (Univ., Innsbruck). Strahlentherapie, 136: 738-49(Dec. 1968). (In German).

After inhalation of radon $^{222}Rn$ and thoron $^{220}Rn$ not only are these noble gases incorpor[illegible], but also their decay products connected with the aerosols present. The latter, however, are filtered off in the respiratory tract; from there they are transferred to the blood, chiefly by direct resorption from the alveoli but also via the digestive tract. The blood distributes them to all parts of the body. Extensive experiments with animals and man (some of the animals with esophagus ligature) permitted a determination of the distribution of these radionuclides in the organism. It could be shown that the concentrations of decay products in the individual organs and tissues are quite different depending on their chemical affinity. The dose distribution in the human organism could be estimated from the organ activities obtained in the animal experiments. (auth)

**29323** EFFECTS OF LITHIUM SALTS ON PLASMA PROTEIN BOUND IODINE AND UPTAKE OF $^{131}I$ IN THYROID GLAND OF MAN AND RAT. Sedvall, G.; Joensson, B.; Pettersson, U.; Levin, K. (Karolinska Institutet, Stockholm). Life Sci., 7: 1257-64(Dec. 1, 1968).

Radioiodine metabolism was studied in humans after administration of Li salts. The daily dose of Li carbonate was 900 to 1800 mg. Uptake of $^{131}I$ in thyroid gland was determined 24 hr after administration of $^{131}I$ in patients after being admitted and about two weeks later. The manic-depressive patients had been maintained on Li for 7 to 20 days. The $^{131}I$ retention in the patients was markedly increased during Li carbonate administration. Serum protein-bound I (PBI) was significantly reduced during administration of Li carbonate. There was no evidence of a reduced capacity of the thyroxine binding proteins in the serum. On the contrary, there was a tendency for an increased unsaturated binding capacity. Reduced PBI values and increased triiodothyronine-binding capacity are expected in conditions with a diminished release of thyroxine from the thyroid gland. The previous observation of a prolonged biological half-life of $^{131}I$ in the thyroid gland of patients treated with Li carbonate is compatible with the present findings which indicate that Li interferes with thyroxine secretion. (BBB)

**29324** BEHAVIOR OF DOMESTIC FUNGUS TYPES IN RELATION TO THE FISSION PRODUCT $^{137}Cs$. Grueter, H.

(Univ., Muenster, Ger.). Z. Lebensm.-Untersuch. Forsch., 134: 173-9(1967). (In German).

Investigations on the artificial radioactivity of vegetation as a result of nuclear war research showed an unusually high concentration of the fission product $^{137}Cs$ in various fungi. Although in the ground several fission products are present, aside from $^{137}Cs$ and a small amount of $^{90}Sr$ none of the other artificial isotopes were absorbed in the mineral content of the fungus. In contrast to K, which makes up the greatest part of the inorganic fungus constituents, $^{137}Cs$ was preferentially enriched with respect to the $^{137}Cs$ concentration in the ground by more than one order of magnitude. The nature of the soil has a very strong effect on the $^{137}Cs$ content of the fungus: pine needle ground gave the highest value, deciduous forest was significantly less and meadows yielded no detectable fission product activity. In a cooking experiment with Paxillus involutus, 64% of the $^{137}Cs$ activity passed over into the cooking water. (tr-auth)

**29325** EARLY CHANGES IN THE ABSORBABILITY OF $^{131}I$ BY THE THYROID IN ACUTE EXPERIMENTAL INTOXICATION WITH DITHANE M-45. Ivanova-Chemishanska, L.; Mosheva-Izmirova, N. (Inst. of Labor Safety Precautions and Occupational Diseases, Sofia). Compt. Rend. Acad. Bulg. Sci., 21: 965-7 (1968).

Mankozeb was given orally to rats. Twenty-four hours later $^{131}I$ was injected intraperitoneally into experimental and control rats. The tabulated results show a marked decrease in $^{131}I$ uptake in the thyroid of experimental rats. Toxic effects of metabolites of dithiocarbamates are discussed. (H.L.W.)

**29326** CATION EXCHANGE PROPERTIES OF BONE TISSUE. Anghileri, L. J. (Johns Hopkins Medical Institutions, Baltimore). Experientia, 25: 283(Mar. 15, 1969).

Bones are known to possess a high uptake rate for chromium-51 and $\beta$-glycerophosphate. The present findings indicate that a simple cation exchange mechanism causes the deposit of chromium as an insoluble compound. (H.B.G.)

**29327** THE EFFECT OF CHOLINE CHLORIDE AND STRONTIUM CHLORIDE ON THE $^{45}Ca$-EFFLUX IN THE GUINEA PIG AURICLE. Glitsch, H. G.; Reuter, H. Arch. Pharmakol. Exp. Pathol., 260: 121-2(June 21, 1968). (In German).

Changes in the slow component of the $^{45}Ca$ efflux from the left auricle of the guinea pig can be described quantitatively, if a carrier-mediated exchange is assumed. Extracellular $Na^+$ and $Ca^{2+}$ ions compete for this carrier on the external myocardial cell membrane. The extracellular $[Ca^{2+}]/[Na^+]^2$ ratio determines the particular fraction of $Na^+$ or $Ca^{2+}$ associated with the $^{45}Ca$ efflux. If the $^{45}Ca$ efflux in inactive Tyrode solution containing the normal amounts of $Na^+$ and $Ca^{2+}$ is taken to be equal to one, then the efflux of a Ca-free Tyrode solution whose entire NaCl is replaced with choline chloride is reduced by about 25%. If the $CaCl_2$ is replaced by an equimolar amount of $SrCl_2$, then the $^{45}Ca$ efflux is essentially unchanged. Thus, $Na^+$ cannot be replaced by choline chloride for activation of the $^{45}Ca$ efflux, but $^{45}Ca$ efflux in the guinea pig auricle is relatively the same whether $Ca^{2+}$ or $Sr^{2+}$ ions are present. (BBB)

**29328** RELATION BETWEEN EXCRETION OF RADIONUCLIDES AND BURDEN OF RADIOACTIVITY IN THE BODY. Furnica, Gh.; Racoveanu, N. (Institutul de Igiena, Bucharest). Igiena (Bucharest), 17: 223-32(Apr. 1968). (In Rumanian).

Correlations with whole-body content of radioisotopes were made from the rates of their excretion. Theoretical equations were derived for quantities excreted as a function of time from the incorporation of a single dose. The rate of excretion of various radioisotopes varied as a function of the metabolic routes followed by each nuclide, requiring several metabolic periods. Soluble $^{90}Sr$ was excreted as $11.6 \exp(-0.693t/2.4) + 8t^{-1.2}$; soluble $^{137}Cs$ as $6.2 \exp(-0.693t) + 0.5 \exp(-0.693t/110)$; soluble $^{226}Ra$ as $0.56t^{-1.5}$; $^{32}P$ as $20 \exp(-0.693t/0.5) + 5 \exp(-0.693t/2) + 1.4 \exp(-0.693t/18)$; soluble $^{35}S$ is excreted as $200 \exp(-0.693t/0.25) + 2 \exp(0.693t/7)$; and soluble $^{210}Po$ as $0.14 \exp(-0.693t/50)$; $T_2$ as $3.5 \exp(-0.693/12)$. Data are also presented graphically for ThX and thoron, and soluble and insoluble U. Single doses were given to man. Equations are given for the rate of urinary elimination and are graphically correlated with the percentage of nuclide eliminated in urine of the original amount incorporated as a function of time. (BBB)

**29329** THE ELIMINATION OF $^{131}I$ IN BRONCHOTRACHEAL SECRETIONS OF GUINEA PIGS. 3. ANALYSIS OF THE SECRETIONS. Gruss, J. D.; Krueger, F. W.; Hoebel, M. (Univ., Heidelberg). Arch. Int. Pharmacodyn., 169: 394-402(Oct. 1967). (In German).

Compounds of $^{131}I$ in the bronchotracheal secretions of guinea pigs 12 hr after injection of $^{131}I$ were studied by paper chromatography, microscopically, and by ultracentrifugation. Uptake of $^{131}I$ by Escherichia coli, Proteus vulgaris, and nonhemolytic streptococci from samples of the bronchotracheal secretions was measured. After $^{131}I$-iodide or $^{131}I$-labeled L-thyroxine was added to the nutrient media no chromatographically demonstrable substances with $^{131}I$ were detected. Most of the $^{131}I$ in the secretions consisted of $I^-$. Some $^{131}I$-labeled iodate was detected, and infrequently a third $^{131}I$-compound was found, that may have been a secondary product produced by oxidation or metabolic reactions. Generally, the $^{131}I$ concentrations in the tracheal walls and in the bronchotracheal secretions were greater than in the plasma, which indicated that the $^{131}I$ was bound in an active transport system. Small amounts of a sediment that contained unidentified $^{131}I$ activity were found following ultracentrifugation of the bronchotracheal secretions. (BBB)

**29330** EFFECT OF PLASMA IODIDE CONCENTRATION UPON THYROIDAL IODIDE UPTAKE. Heiskanen, T.; Krusius, F.-E.; Salminen, S. (Univ. of Helsinki). Scand. J. Clin. Lab. Invest., 22: 147-50(Oct. 1968).

The kinetics of thyroid uptake of iodide were examined by determining the change of radioiodide uptake after injection of two separate doses of stable iodide. In the test procedure a carrier-free solution of $^{131}I$ was injected intravenously in a patient and the activity over the thyroid and the heart was continuously measured by collimated detectors. After about 40 min an intravenous injection of stable iodide (100 to 400 $\mu$g) was administered and after a further 40 min a second injection of a 2-fold amount of iodide was given. The rate of accumulation of radioiodide by the thyroid decreased after each injection of stable iodide. Because of difficulties involved in the measuring technique when the initial radioiodide uptake rate was small, the series comprised mainly thyrotoxic cases. From the calculated results it was seen that the concentration-dependent influx of iodide into the thyroid was smaller than the concentration-independent influx. On an average, the concentration-dependent influx was less than 1% of the total influx. Thus, the iodide influx is only slightly increased in relation to the increase of the plasma iodide concentration. (BBB)

**29331** EFFECT OF CODEINE ON THYROID FUNCTION IN THE RAT. Schreiber, V.; Zbuzek, V.; Zbuzkova-Kmentova, V. (Charles Univ., Prague). Physiol. Bohemoslov., 17: 253-8(1968).

The administration of codeine in 0.04% concentration to adult male rats in food for 14 days inhibited the accumulation of $^{131}I$ in the thyroid. The effect was caused partly, but not entirely, by the decrease in food intake. Codeine did not influence hypertrophy of the thyroid and the hypophysis after a methylthiouracil block of the thyroid. (auth)

**29332** DISPERSING OF RADIOACTIVE SODIUM AND POTASSIUM PREPARATIONS APPLIED ON THE SURFACE OF PLANTS, AS A SOURCE OF MISINTERPRETATIONS IN BIOLOGICAL EXPERIMENTS. Antoszewski, R.; Lis, Elwira K. (Research Inst. of Pomology, Skierniewice, Poland). Biol. Plant., Acad. Sci. Bohemoslov., 10: 257-8(1968).

Abnormalities were observed in the transport of $^{24}NaCl$ and $^{42}KCl$ in the strawberry following application on the surface of the leaf, on the epidermis of the peduncle, and the receptacle. Model experiments were conducted to explain this phenomenon. Drops of a solution of $^{24}NaCl$ and $^{42}KCl$ were air dried at 20°C. After 24 hr the radioactivity of polyethylene films and blotting paper used under and around the drops was measured. The $^{24}NaCl$- and $^{42}KCl$-containing spots were detectable autoradiographically. Randomly distributed contamination of films placed around the radioactive spot was found. Results indicated that the radioactive preparations had burst during the crystallization process. A similar effect was observed when radioactive preparations were dried under ir light for chromatographic purposes. The total amount of radioactive preparation dispersed was relatively small. For $^{24}NaCl$ it was not more than 0.35% and for $^{42}KCl$ it was not more than 0.03%. (BBB)

**29333** $^{133}Xe$ MYOCARDIAL BLOOD FLOW DETERMINATION: A SIMPLE NEW BALLOON TECHNIQUE. Dietzman, Ronald H.; Nordberg, David; Loken, Merle K.; Lillehei, Richard C. (Univ. of Minnesota, Minneapolis). J. Appl. Physiol., 24: 840-3(June 1968).

A new balloon cannula technique for $^{133}Xe$ measurement of myocardial blood flow is described. The clearance curve of $^{133}Xe$ from heart muscle following its selective injection into the coronary artery is known to be correlated with myocardial blood flow. The technique of delivery was modified using a special cannula with an attached balloon which occluded the aorta above the orifices of the coronary arteries for a brief time while $^{133}Xe$ was flushed into the coronary circulation. This greatly simplified the performance of myocardial blood flow determinations in the intact animal

and retained the accuracy and speed of the original selective catheterization technique. The use of $^{133}Xe$ rather than $^{85}Kr$ facilitates external counting. The theoretical and experimental justification for the technique of $^{133}Xe$ myocardial blood flow measurement was referenced. Findings obtained on the reproducibility of the measurements by the new balloon technique and comparison of values obtained by the selective catheterization technique were discussed and described in detail. The myocardial blood flow measurements obtained compared well with values obtained by injection via a selective coronary artery catheter and were reproducible. This method has the advantage of simplicity and can be performed without fluoroscopy and experience in selective coronary artery catheterization. (BBB)

**29334** RADIOAUTOGRAPHIC STUDY OF THE DISTRIBUTION OF INHALED MERCURY ($^{203}Hg$) IN THE BRAIN OF THE RAT AND MOUSE. Cassano, G. B.; Amaducci, L.; Viola, P. L. (Univ. Pisa, Italy). Acta Neurol. Psychiat. Belg., 67: 1099-1103(1967). (In French).

Both macro- and microautoradiography were used to determine the distribution of $^{203}Hg$ in mice and rats exposed to $^{203}Hg$ vapor for 6 hr/day for 10 days. The animals were sacrificed after 1 to 16 days. Whole-body autoradiography revealed the presence of $^{203}Hg$ in kidney, myocardium, brain, and to a small extent in the liver. Considerable radioactivity was found in the central nervous system even 16 days postinhalation. In brain, more $^{203}Hg$ was present in gray matter than white matter. The strongest concentrations were in cerebral cortex, cerebellum, hypothalamus, thalamus, mesencephalon, pons, and spinal cord. There were concentrations both in cytoplasm and projections of nerve cells. Walls of capillaries in brain showed concentrations of $^{203}Hg$. Biochemical studies showed more of the $^{203}Hg$ in the water-soluble brain fractions than in lipid-soluble fractions. (BBB)

**29335** RELATIVE IMPORTANCE OF STEM AND ROOT IN DETERMINING GENOTYPIC DIFFERENCES IN $^{89}Sr$ AND $^{45}Ca$ ACCUMULATION IN SOYBEANS (GLYCINE MAX L.). Kleese, R. A. (Univ. of Minnesota, St. Paul). Contract AT(11-1)-1097. Crop Sci., 7: 53-5(Jan.-Feb. 1967).

Stem grafts were made among 8- to 10-day-old soybean plants to ascertain the role of stem and root in determining varietal differences in accumulation of $^{89}Sr$ and $^{45}Ca$ in seed and in the terminal portion of the stem. The effect of the graft per se was negligible as evidenced by similar $^{89}Sr$ and $^{45}Ca$ accumulation in grafted plants with stem and root of identical genotype and the ungrafted plants of the same genotype. Accumulation of $^{89}Sr$ and $^{45}Ca$ in seeds was largely controlled by the genotype of the stem. In the terminal 12 to 15 cm of the stem $^{89}Sr$ and $^{45}Ca$ accumulation was controlled by both stem and root, with the stem being relatively more important. (auth)

**29336** ALTERATIONS OF IODINE METABOLISM IN ASYMPTOMATIC THYROIDITIS. Camus, M.; Ermans, A. M.; Bastenie, P. A. (Hopital St. Pierre, Brussels). Metab., Clin. Exp., 17: 1064-72(Dec. 1968).

Radioiodine metabolism was studied in patients affected with asymptomatic autoimmune thyroiditis, as indicated by a significant titer of serum thyroglobulin antibodies, in the absence of overt thyroid disease. When matched with adequate controls, these subjects fail to show significant changes of $^{131}I$ thyroid uptake, which was, however, markedly depressed by triiodothyronine and KI. The plasma $PB^{125}I$ was increased. After a single injection of thyrotropin (TSH), the iodine trapping was normally enhanced, but after 24 hr, the radioactivity of the thyroid was lower than in control subjects. It was shown that this phenomenon was related to the discharge from the thyroid of PBI with abnormally high activity. Kinetic studies indicated a 2 to 1 reduction of the thyroid exchangeable organic I, as well as of the thyroid $^{131}I$ half life. The fraction of plasma PBI extracted by butanol was 73 ± 15% in the thyroiditis patients, contrasting with a value of 93 ± 6% in the controls. Radioiodine metabolism anomalies observed in asymptomatic thyroiditis may be explained by the reduction of the exchangeable I in the thyroid and its increased turnover. However, the interference of an underlying congenital metabolic defect cannot be excluded. (BBB)

**29337** VARIATION WITH TIME OF THE DISTRIBUTION OF $^{228}Ra$ AND $^{224}Ra$ IN THE RES AND MARROW-FREE SKELETON AFTER INCORPORATION OF COLLOIDAL $ThO_2$ (THOROTRAST). Kaul, A. (Freie Univ., Berlin); Heyder, J. Biophysik, 5: 331-40(1969). (In German).

Animal experiments were done in order to answer the question for the variation with time of both the distribution of $^{232}Th$ and its daughters and the activity ratios between the radionuclides of the thorium decay chain immediately after incorporation of thorotrast. The results of these investigations indicate a continuous elimination of $^{224}Ra$ from $ThO_2$-aggregates in the organs of the RES, liver, spleen, and red bone marrow. According to the variation with time of the activity ratio between $^{224}Ra$ and $^{228}Th$, even from the first day after incorporation, about 35% of the $^{224}Ra$ atoms formed in the aggregates may leave the aggregates due to a recoil at $\alpha$-decay of $^{228}Th$ and will be eliminated from the organs of the RES. This means that at least at that time the process of aggregation of the $ThO_2$-particles within the organs of the RES has to be finished. This portion of $^{224}Ra$ being eliminated from the RES is partly translocated into the marrow-free skeleton. The same is true for the portion of $^{224}Ra$ and $^{228}Ra$ in ionic form at the total activity of the suspension, that means, according to the range of the $^{228}Ra$ and $^{224}Ra$ recoil atoms within the $ThO_2$-particles, for 80% to 90% of the total $^{228}Ra$ and $^{224}Ra$ activity of the suspension. From the variation with time of the specific $^{228}Ra$ activity of marrow-free bone it could be seen that $^{228}Ra$ and $^{224}Ra$ being fixed in the marrow-free skeleton in ionic form at the time of incorporation is eliminated from the skeleton according to a potential function. As consequence of a continuous translocation of $^{224}Ra$ to the skeleton due to decay of $^{228}Th$ within the organs of the RES the specific $^{224}Ra$ activity of marrow-free bone proved to be constant between 10 and about 100 days after incorporation of thorotrast, considering decay of $^{224}Ra$ within the skeleton and its elimination from the skeleton. The experimental results were correlated to those of a theoretical model describing translocation of $^{224}Ra$ from the RES to the marrow-free skeleton and its excretion from the skeleton and the body. The agreement of the results indicate that the model describes the experimental retention of $^{224}Ra$ and may be a basis for calculating the cumulative radiation dose in the skeleton as function of time after thorotrast incorporation. (auth)

**29338** AGRONOMIC FACTORS AFFECTING $^{210}Po$ AND $^{210}Pb$ LEVELS IN TOBACCO. II. VARIETIES AND CURING METHODS. Tso, T. C. (Agricultural Research Service, Beltsville, Md.); Carr, J. M.; Ferri, E. S.; Baratta, E. J. Agron. J., 60: 650-2 (Nov.-Dec. 1968).

Tobacco seedlings accumulated $^{210}Pb$ and $^{210}Po$ to a concentration much higher than that found in the soil. The levels of these radioelements decreased as the plants grew. Only minor differences were observed in harvested leaves of 2 flue-cured varieties: Coker 319 and Virginia Bright Leaf. The $^{210}Pb$ and $^{210}Po$ content in the seeds is much lower than that in the respective leaves produced from the same plant. Neither of the 2 methods of flue-curing (a closed system with wood or an open system with kerosene) resulted in significant differences in radioisotope levels of cured leaf. The $^{210}Pb$ and $^{210}Po$, if present in the combustion products of weed, were trapped in or exhausted through the flue pipes and were not deposited on the tobacco. Kerosene, because it contains little radioactivity, would not contribute much to the $^{210}Pb$ and $^{210}Po$ level of cured leaf when fully exposed to products of combustion in an open system. (BBB)

**29339** DECORPORATION OF RADIONUCLIDES: STUDIES ON RADIOMANGANESE. Kuhn, Anne (Kernforschungszentrum, Karlsruhe, Ger.). Strahlentherapie, 137: 101-9(Jan. 1969). (In German).

The distribution and excretion of carrier-free and isotopically diluted $^{54}Mn$ as influenced by various chelating agents were studied in the rat. Diethylenetriaminepentaacetic acid and cyclohexanediaminetetraacetic acid exhibit the highest efficacy. In the chronic treatment situation, the Mn–chelates are markedly more effective than the Ca-chelates. The underlying mechanisms are discussed. (auth)

**29340** EFFECT OF TESTOSTERONE PROPIONATE ON THE DISTRIBUTION OF RADIOACTIVE IODIDE IN RECENTLY THYROIDECTOMIZED RATS. Driessen, O. M. J.; Noach, E. L. (Univ. of Leiden). Acta Endocrinol., 60: 303-14(Feb. 1969).

In thyroidectomized rats, pretreatment with testosterone propionate (TP) resulted in an increased disappearance rate of injected $^{131}I$ from the blood. This was not due to an increase in renal iodide clearance; on the contrary, renal reabsorption of iodide was enhanced after TP pretreatment. Greatly increased uptake of iodide in the skin was shown to account for most of the more rapid disappearance of iodide from the blood in TP-pretreated, recently thyroidectomized (euthyroid) rats. The distribution of intravenously administered $^{131}I$ was studied in sprayed rats that were thyroidectomized on the previous day. Pretreatment with TP (2 mg daily for 8 days) resulted in decreased $^{131}I$ blood levels both in non-nephrectomized and nephrectomized animals. In the latter, no loss of radioactivity from the body occurred within the time limits of the experiments (up to 10 hr after $^{131}I$ administration). In most organs, $^{131}I$ concentrations were lower after TP pretreatment, but in the skin a markedly increased uptake was found. To a minor extent, enhanced concentration of $^{131}I$ was present in an extrahepatic abdominal storage site. (BBB)

**29341** UPTAKE OF LABELLED VITAMIN $B_{12}$ AND 4-IODOPHENYLALANINE IN SOME TUMOURS OF MICE. Blomquist, L.; Flodh, H.; Ullberg, S. (Royal Veterinary Coll., Stockholm). Experientia, 25: 294-6(Mar. 15, 1969).

Whole-body autoradiography was performed in tumor-bearing mice following injection of vitamin B12 (labeled with either cobalt-57 or cobalt 60) and iodine-125-labeled 4-iodophenylalanine. Increased uptake was found in soft fibroplastic osteosarcomas induced by strontium-90; whereas, 4-iodophenylalanine accumulated in Ehrlich ascites tumor cells. (H.B.G.)

## *Radiation Effects*

*Refer also to abstracts 28912, 29297, 29412, 29414, 29439, 29476, 29566, 29584, 29716, 29718, 29736, 29754, 29779, 29780, 29804, 29810, 29924, 29932, and 29949.*

**29342** (CEA-R-3679) RADIOPROTECTIVE PROPERTIES OF CERTAIN NITROGENOUS COMPOUNDS HETEROCYCLIC ON THE SERUM PROTEINS OF IRRADIATED MICE. Pierotti, Theodore; Roushdy, Hamid; Polverelli, Michel; Mazza, Marcel (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Feb. 1969. 26p. (In French). Dep.

The results obtained from this study suggest the following: The concentration of total serum proteins in mice was very little changed during all the treatments carried out, while protein fractions showed significant alterations. The concentrations of various serum proteins remained almost constant under normal conditions. Intraperitoneal administration of imidazole or benzimidazole at the mentioned doses induced rapid quantitative changes in the serum which recovered in about 3 days after injection. Whole-body x irradiation at 750 R created slow but progressive and persisting serious changes in a concentration of serum protein fractions which end by death of animals at 8 to 10 days after irradiation. Whole-body x irradiation of imidazole- or benzimidazole-protected animals resulted in quantitative rapid changes in concentration of serum protein fractions for about four days after which a slow but steady restoration begins. The concentration approaches the normal levels towards the 10th day after irradiation. Imidazole and benzimidazole were proved to be good radioprotectants against the effects of radiation on serum protein fractions. Benzimidazole seems to surpass imidazole. (auth)

**29343** (COO-1313-22) [EFFECTS OF X IRRADIATION ON THE SYNTHESIS AND FUNCTION OF RNA AND PROTEIN IN PLANTS]. Technical Progress Report. [Cherry, Joe H.] (Purdue Univ., Lafayette, Ind.). [1969]. Contract AT(11-1)-1313. 18p. Dep. CFSTI.

Six fractions of nucleic acids were characterized by several parameters and their metabolism studied during seed germination and plant growth. Preparations containing predominately nuclei synthesize in vitro transfer and ribosomal RNA. It isn't clear whether the nuclei also synthesize RNA equivalent to m-RNA. Auxin at appropriate concentration promote RNA synthesis by the nuclei system. Doses of x-irradiation may promote or inhibit the accumulation of various precursors into RNA depending on the time the seeds were stored after x-irradiation. Seeds germinated soon after x-irradiation accumulated more precursor into RNA. On the other hand, seeds stored 4 weeks after x-irradiated were greatly inhibited in their capacity to synthesize RNA. From studies dealing with protein synthesis (in vivo and in vitro), it is concluded that x-irradiation does not alter ribosomes or aminoacyl synthetase but does inhibit the synthesis of functional mRNA. Studies dealing with the effect of x-irradiation on the synthesis of invertase in sugar beet disks show that x-irradiation promotes the development of invertase during washing, ethylene and ethionine inhibit invertase synthesis, the ethionine inhibition can be partially reversed by methionine and gibberellic acid, x-irradiation reduces by 50% the development of RNA polymerase associated with chromatin and x-irradiation prevents the normal gene depression as measured by total template. (auth)

**29344** (COO-1704-6) CORRELATION BETWEEN RADIATION AND CHEMICAL INDUCED MOLECULAR DAMAGES AND THEIR BIOLOGICAL EXPRESSION IN MAMMALIAN CELLS. Annual Technical Progress Report. Trosko, James E. (Michigan State Univ., East Lansing. Dept. of Natural Science). [1968]. Contract AT(11-1)-1704. 9p. Dep. CFSTI.

The role of pyrimidine dimers in uv-induced damage and the photoreactivation of uv-induced molecular damage in DNA of cultured cells of Nicotiana tabacum and Ginkgo biloba were studied using $^3$H-thymidine as a tracer. Techniques were developed for measuring the molecular weight of DNA in situ in mammalian cells. The method was applied to studies of uv-induced single strand breaks in DNA in nuclei of hamster cells. Synthesis of DNA was inhibited by platinum but stimulated by caffeine in cultured human cells. (C.H.)

**29345** (SPR-10) INFLUENCE OF DEGRADATION PRODUCTS OF IRRADIATED GLUCOSE SOLUTIONS ON HUMAN FIBROBLASTS. I. GLYOXAL. Kellner, G.; Kaindl, K. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Biologie und Landwirtschaft). Apr. 1967. 4p. Dep.

The effect of glyoxal was investigated on human fibroblasts in a cell culture and it was shown that a relatively high degree of toxicity was produced within a wide range of concentrations. At lower concentrations (3 $\mu$g per ml) glyoxal had a stimulating effect on cell growth. With a 10 times higher dose a degree of toxicity of approximately $5.0 \times 10^{-12}$ g glyoxal per cell per hour was reached and the toxicity decreased again at 100 $\mu$g per ml. Glyoxal could be degraded within 24 hours, or at least neutralized, by the fibroblasts and thus rendered toxically harmless. (auth)

**29346** (UCD-34-P-112-41) RADIATION BIOCHEMISTRY OF FRUIT: MOLECULAR ASPECTS OF CYTOPLASMIC RECOVERY AND REPAIR FOLLOWING MASSIVE IRRADIATION. Final Report, January 1-December 31, 1968. Romani, Roger J. (California Univ., Davis. Dept. of Pomology). Mar. 28, 1969. Contract AT(11-1)-34. 24p. Dep. CFSTI.

Radiation Biochemistry of Fruit Experiments demonstrating the response of pear fruit mitochondria to massive doses of $^{60}$Co $\gamma$ radiation was conducted and is described in three phases: studies demonstrating the in vivo repair of radiation damage to mitochondria; studies describing the response of the ribosomal system to massive doses of $^{60}$Co $\gamma$ radiation, in vivo, and explorations in the response of mitochondria to ionizing radiation, in vitro. Regarding the first phase, mitochondrial repair reactions were established utilizing split radiation doses and the dynamics of post-radiation repair are discussed. The direct relation between cell age and the capacity to compensate for radiation injury was also demonstrated. Based on these and other experiments, it was concluded that pear fruit mitochondria could tolerate and recover from radiation doses up to 1 Mrad and that this capacity was to a certain extent dependent on the age of the fruit cells. In the phase of study dealing with the response of the ribosomal systems, in vivo, to radiation, the following accomplishments are reported: development of methods for isolating and characterizing pear ribosomes; demonstration of the continuous decline in the rate of ribosomal synthesis with aging and the complete cessation of ribosomal turnover at the climacteric peak of the fruit; demonstration of the complete loss of the ability by the cell to compensate for damage to the ribosomal system as a function of age; and determination of the effects of two doses of $^{60}$Co $\gamma$ radiation (250 Krad and 1000 Krad) on ribosomal synthesis. The lower dose increased the rate of synthesis while at the higher dose, complete cessation of synthesis occurred. Experiments on the in vitro response of mitochondria to radiation revealed the following: radiation doses of 56 to $1 \times 10^6$ rad resulted in no marked effect on respiratory control while doses between 250 and 500 Krad actually increased respiratory control; incubation at 20°C following irradiation at 0°C at a dose rate of 250 Krads/hr led to increased respiratory control at 250 Krads, delayed increase of respiratory control at 500 Krads and complete cessation of respiratory control at 1000 Krads; and protein synthesis was markedly depressed following irradiation at doses of 1250 Krads and the addition of cycloheximide or puromycin to the cultures did not cause a reduction in respiratory control in either the irradiated or control groups. Experiments in which the longevity of pear and avocado mitochondria was determined in vitro led to the conclusion that isolated, coupled mitochondria capable of respiratory control on the order of three or four could maintain respiratory control as long as 24 hrs at 20 to 25°C. This ability constitutes a more critical index of organelle integrity than respiratory control per se when determining the effects of environmental stress on isolated mitochondria. (E.R.B.)

**29347** (UCRL-18347, pp 149-54) RELATIVE EFFECTS OF RADIATION ON DE NOVO DNA BASE SYNTHESIS AND THYMIDINE INCORPORATION INTO DNA. Winchell, H. Saul; Vimokesant, Serene L.; Raley, Rosanne B. (California Univ., Berkeley).

Within 0.5 hour after aspiration, dog bone marrow cells were given an exposure dose of x ray in the range of 50 to 3200 R (100 kVp, 15 mA, 0.5-cm Al filter). Within 0.5 hour following the termination of radiation the cultured cells were subjected to short-term incubation in balanced salt solution containing $^{14}$C formate or serine labeled with $^{14}$C in the number 3 position and thymidine labeled with tritium. Following 1.5 hours of incubation at 37°C in

a Dubnoff metabolic shaker, cultured tubes were immediately placed on ice and the cells washed with iced culture media, and DNA was isolated. The washed cells were disrupted by freeze-thawing in acetone-dry ice and washed in saline, and the nucleic acids were dissolved by using sodium dodecyl sulfate (final concentration 0.4%); RNA was precipitated by adjustment of the salt concentration to 1M sodium chloride; and DNA was precipitated from the supernate by the addition of alcohol, dried, and hydrolyzed in formic acid at 175°C for 35 minutes in a sealed container. The hydrolyzed DNA bases were then separated by paper chromatography. Adenine and thymine were eluted from the chromatogram by use of 0.01 N HCl and the concentration of adenine and thymine within the eluate determined by uv absorption spectroscopy, and the samples were counted for tritium and $^{14}C$ activity by liquid scintillation counting. The synthesis of DNA thymine and adenine utilizing monocarbon units from $^{14}C$-labeled formate or #3-$^{14}C$-labeled serine was found to be more radiosensitive than the incorporation of tritiated thymidine into DNA thymine. Since the de novo synthesis of both the pyrimidine thymine and the purine adenine was markedly suppressed following radiation, we postulate that the common metabolic pathway requiring monocarbon transport needed in the synthesis of both these bases may be markedly radiosensitive. Furthermore we postulate that this step is more radiosensitive than metabolic steps required for the incorporation of DNA bases into the DNA molecule. Results suggest that following radiation the incorporation of tritiated thymidine into DNA is not a good measure of overall DNA synthesis, but may rather be a measure of the incorporation of preformed thymidine, from reutilization pathways, into DNA. (auth)

**29348** A QUANTUM-MECHANICAL HYPOTHESIS FOR THE MECHANISM OF ENZYME REACTIONS (A QUANTUM APPROACH TO ENZYMOLOGY). Comorosan, Sorin (Fundeni Clinical Hospital, Bucharest). Enzymologia, 35: 117-30(Sept. 30, 1968).

Studies on the effect of x irradiation of the substrate on enzyme activity were used to provide evidence supporting a quantum-theoretic approach to the mechanism of enzyme reactions that is proposed. The substrate of a particular enzymic reaction is considered as a microphysical system, i.e., an ensemble of observables that characterize the respective chemical species. A substrate information observable I is assumed to carry the physical attribute that corresponds to the affinity between the enzyme and its substrate. A suitable microphysical measuring apparatus, identified as the enzyme, specifies the eigenvalues of this observable I on particular quantum states $\psi_i$. It is demonstrated that this picture is compatible with the general principles of measurability in quantum mechanics. Experimental evidence for the above concept is given. Different biochemical substrates were subjected to low x-ray doses in such a way as not to alter their chemical structure. The following enzymes were investigated: urease, succinate dehydrogenase, lactate dehydrogenase, and glutamate dehydrogenase. Urea was irradiated with single doses of from one to 100 R of x radiation. The substrates for the dehydrogenases were irradiated with single doses of 10 and 100 R. It was shown that a stimulation of the enzymic reaction with urease is obtained with a dose ranging from one to 7 R and an inhibition of the reaction is obtained when the substrate is irradiated with a higher dose. Nevertheless, when the specific nonenzymic chemical color reaction with diacetyl monoxime was performed, especially the same extinction coefficients (E1%/1 cm) were obtained on the irradiated as compared with the nonirradiated samples, within all investigated dose ranges. It was concluded that these perturbed substrates showed significant changes in the enzyme-substrate complex formation, according to the predictions of the theory. The relation of the quantum approach to current enzymology and the possible biological implications are discussed. (BBB)

**29349** EFFECTS OF GAMMA-RADIATION ON SOLUTIONS OF RIBONUCLEASE. Marshall, Michael; Gibson J. Anthony B.; Docherty, John (Atomic Energy Research Establishment, Harwell, Eng.). Int. J. Radiat. Biol., 14: 391-3(1968).

An investigation was made to determine whether differences in the response of RNAase to irradiation as reported in the literature are caused by actual differences in the enzymes or by differences in methods of analysis. Four types of RNAase were irradiated in $N_2$ or $O_2$ with 2.5 Krad/min from a $^{60}Co$ source. The enzymatic activity of all types of RNAase decreased exponentially with radiation dose. The dose at which the enzymatic activity decreased by a factor of 2.72, and the ratio of this dose in $N_2$ to this dose in $O_2$ were calculated for each enzyme. It was concluded that the purity of an enzyme has an effect on radiosensitivity, but the method of analysis is far more important in producing differences among authors. (M.M.B.)

**29350** EXCRETION OF 5-HYDROXYINDOLEACETIC ACID IN 24-HOUR URINE IN PATIENTS WITH SKIN EPITHELIOMA TREATED WITH X RAYS. Tyszlukiewicz, Danuta (Academy of Medicine, Lublin). Pol. Tyg. Lek., 23: 1802-4(Nov. 18, 1968). (In Polish).

Urinary levels of 5-hydroxyindoleacetic acid (5-HIAA) were followed in 33 patients with facial skin basocellular and acanthomatous epitheliomas and in two cases of keratoacanthoma prior to and during treatment with x rays. The patients received electrocoagulation and 1000 R daily doses for six days ($R_1$ method), or 250 to 300 R daily for 17 to 21 days ($R_2$ method). The level of 5-HIAA was determined by the method of MacFarlane, et al. No differences in the excretion of 5-HIAA in relation to the size, duration, and type of neoplasm or to the sex of the patient were seen. It was shown that electrocoagulation and method $R_1$, unlike method $R_2$, caused a significant increase of 5-HIAA excretion in 24-hr urine. (BBB)

**29351** DNA SPECTROPHOTOMETRIC CHARACTERIZATION AFTER IRRADIATION IN VIVO. II. THERMAL TRANSITION AND INFLUENCE EXERTED BY RADIOPROTECTIVE (AET) AND RADIOSENSITIZING (COCARBOXYLASE) SUBSTANCES. Furnica, Maria (Oncologic Inst., Bucharest). Rev. Roum. Biochim., 5: 113-20(1968).

Parameters reflecting thermally induced changes in DNA, including melting temperature (Tm), the transition width ($\Delta 2/3$), and absorption difference at 25°C after denaturation and at Tm ($\Delta T$), were determined in the DNA extracted from liver of rats irradiated by lethal doses (900 R) or nonlethal ones (300 R) were studied. The results indicated some of the structural changes undergone by the DNA macromolecule after irradiation in vivo. An increased resistance to heat (Tm = 90°) of DNA extracted from animals irradiated by lethal doses was found, but only in the late phases postirradiation (after 10 days). Administration of cocarboxylase + irradiation with 900 R hastened the effect, the increase of Tm being found as early as three days after irradiation (Tm = 87.7°). Irradiation after administering of AET diminished the irradiation effects, namely DNA extracted after 10 days was less resistant to heat (Tm = 87.5). It was also found out that $\Delta 2/3$, although equal in absolute values for the various DNA preparations, is situated in different temperature ranges in the case of DNA irradiated by lethal doses, as compared with that irradiated by nonlethal doses or the unirradiated material. (BBB)

**29352** EFFECTS OF X RAYS ON THE ULTRASTRUCTURE OF IMMUNOLOGICALLY ACTIVE CELLS OF THE INTESTINAL SUBMUCOSA OF THE MOUSE. Deby, Carol; Malkani, Kanaya (Univ., Algiers). Pathol. Biol., Sem. Hop., 16: 739-49(Aug.-Sept. 1968). (In French).

Forty mice received a single whole-body dose of 800 R of x rays, and electron microscopic studies were made of intestinal submucosa at six hr to 12 days later. Phagocytic activity disappeared 24 hr after irradiation, as seen by the accumulation of debris of damaged cells at this time. No blast cells were seen in the irradiated series by the 1st observation time, six hr postirradiation, nor at any time during the experimental period. Lymphocytes showed total destruction by the sixth hr. A few immature plasma cells were seen by the second to third day, and by the fourth day the number of mature forms was markedly increased. The changes in fine structure of the irradiated cells were similar to those seen in other irradiated cells, such as alteration of mitochondria and progressive disappearance of ribosomes. (BBB)

**29353** SERUM ENZYME ACTIVITY IN MALIGNANT CONDITIONS OF THE UTERUS (UTERINE CANCER) AND THE EFFECT OF UTERINE TRAUMA AS WELL AS OF RADIOTHERAPY ON THE ENZYME ACTIVITY. PART I. Widholm, Olof; Tarjanne, Heikki. Ann. Chir. Gynaecol. Fenn., 56: Suppl. 161, 7-11 (1967).

Changes in the serum activities of glutamic-oxalacetic and glutamic-pyruvic transaminases (GOT, GPT), lactic dehydrogenase (LDH), and alkaline phosphatase were studied in 117 pregnant patients, some of whom underwent radiotherapy. Significantly elevated serum alkaline phosphatase and LDH values occurred only in cases of endometrial carcinoma. Local therapy with Ra or $^{60}Co$ $\gamma$ applicators in 36 cases resulted in slight decline of GOT, GPT, and alkaline phosphatase over two months, followed by slight elevation. However, the changes noted were not uniform, so that few if any conclusions could be drawn. Cervical carcinoma did not cause any increase in the serum activity of these enzymes while the increase noted was significant in corpus carcinoma both with regard to alkaline phosphatase and LDH. This finding may be caused by better vascularization of the endometrium. Pathologico-anatomically and clinically verified necroses of myomas were not reflected in enzyme changes. In a few cases with torquated ovarian tumor, both GOT and LDH values were strongly elevated. (BBB)

**29354** PHOTOCHEMICAL MOVEMENT OF CHOLESTEROL IN SKIN. Rauschkolb, E. W.; Knox, J. M. (Baylor Univ. Coll.

of Medicine, Houston, Tex.). pp 1126-7 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.

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To learn more about the photochemical movement of cholesterol in skin, skin specimens were isolated from the circulatory system and freed from the effects of any other physiological system. The skin specimens were exposed to a full erythema dose of broad-spectrum uv radiation. Analysis of the skin specimens showed that the radiation induced a highly significant reduction in the freely extractable cholesterol. It was concluded that the photodynamic effect on cholesterol was to convert the free form into a sterol firmly associated with a non-hydrolyzable, water soluble moiety. The chemical nature of the sterol conversion product and of the binding substance was not given. (C.O.)

**29355** HELIOTHERAPY AND ITS INFLUENCE ON THE ACTIVITY OF SOME ENZYMES IN PSORIASIS CONDITIONS. Balevska, N.; Petkov, J.; Mustakov, G.; Jowev, S.; Zlatkov, N.; Tomov, G. (Hohes Medizinisches Institut, Sofia). pp 1110-12 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In German).

See CONF-670719-(Vol.2).

The effects of heliotherapy on the activity of some enzymes in psoriasis were studied from 1960 to 1966. The results show that the asparagine transaminase activity is gradually reduced during heliotherapy. The alanine transaminase shows an increase of its activity during heliotherapy, which remains high after the therapy. Cholinesterase, which has a lower value in psoriasis than in control groups, was gradually reduced by heliotherapy. The fructose diphosphate aldolase, which is higher in psoriasis patients than in healthy patients, had its activity increased by heliotherapy. Leucine aminopeptidase showed a reduced activity after therapy. Heliotherapy affects the activity of a series of serum enzymes in patients with psoriasis. (J.S.R.)

**29356** HISTOCHEMISTRY OF ENZYMES OF IRRADIATED FOLLICLES OF GUINEA PIGS. Kint, A.; de Bersaques, J. (Univ., Ghent). pp 1103-6 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In French).

See CONF-670719-(Vol.2).

The histochemistry of irradiated follicles of guinea pigs was studied. Alkaline phosphatase, acid phosphatase, aspecific esterases, proteolytic enzymes, cytochrome oxidase, succinate dehydrogenase, and reductases of tetrazolium bound to NAD and NADP were detected and followed for eight days after irradiation. The results showed that the hydrolytic enzymes underwent no histochemical alterations during the first three days following exposure. There was then a progressive reduction of their activity. The proteolytic enzymes show a moderate increase of their activity beginning on the fourth day after irradiation. Cytochrome-oxidase, succinate dehydrogenase and the reductases remain unchanged for four days and then their activity decreased rapidly. The significance of these results are discussed. (J.S.R.)

**29357** ACUTE EFFECTS OF IRRADIATION ON THE SKIN. A HISTOCHEMICAL AND CHEMICAL STUDY. Kurban, A. K.; Farah, F. S. (American Univ. of Beirut. American Univ. Hospital, Beirut). pp 1090-1 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.

See CONF-670719-(Vol.2).

The acute cellular and enzymatic changes that occur in the epidermis and the chemical alterations in the dermis following x irradiation are briefly reviewed. The changes described were those following a single exposure of 4000 to 6000 R. (C.O.)

**29358** BIOCHEMICAL STUDIES ON SERUM AND SKIN PROTEINS OF RATS FOLLOWING X RADIATION. Rodermund, O.-E. (Univ., Bonn). pp 1091-3 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In German).

See CONF-670719-(Vol.2).

The abdominal skin of rats exposed to high-dose, low-energy x radiation (12 to 20,000 R) was extracted and homogenized. The four fractions were separated by CAF electrophoresis, immunelectrophoresis, and chromatography. In the CAF electrophoresis the fraction I has a diagram similar to the serum protein diagram. Fractions II and III gave only one band. The immunelectrophoresis of fraction I gave precipitate lines corresponding to the serum. In the chromatographic separation fraction I showed, after a strong initial occurrence of folin-positive substances, a flatter more plateau-like notched curve. Fractions II and III showed an initial relatively low basic occurrence of folin-positive substances. An increased initial occurrence of folin-positive substance is found in fraction IV and there is a reduction and flattening of the peaks. (J.S.R.)

**29359** X-RAY MODIFICATION OF THE CATALYTIC AND ALLOSTERIC FUNCTIONS OF FRUCTOSE-1,6-DIPHOSPHATASE. Little, C.; Sanner, T.; Pihl, A. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Biochim. Biophys. Acta, 178: 83-92(Mar. 18, 1969).

The effects of x rays on native fructose-1,6-diphosphatase and fructose-1,6-diphosphatase stimulated by mixed disulfide formation were compared to assess the relative radiosensitivity of the catalytic and the allosteric functions in the native and the stimulated enzyme. The dose response curve for the native enzyme showed an initial stimulation of catalytic activity, followed by subsequent exponential inactivation. The disulfide-modified enzyme was inactivated exponentially with no initial stimulation. The G values for inactivation of catalytic activity were 0.017 and 0.009, respectively. The allosteric activity of the native enzyme, as measured by the inhibition by adenosine monophosphate (AMP), was much more radioresistant than the catalytic activity. In the modified enzyme these 2 functions were of comparable radiosensitivity. The ability of the enzymes to be stimulated by mixed disulfide formation was about 10 times as sensitive to x-ray inactivation as was the catalytic function. Loss of sensitivity to stimulation by disulfides was due to destruction of 5 to 6 specific SH groups which were particularly radiosensitive (G value, 1.2). The x-ray-induced reduction in enzyme activity was associated with destruction of enzyme SH groups of low radiosensitivity (G value, 0.07). The loss of the enzyme activity was partly reversed by addition of cysteamine after exposure. The results indicate that sulfhydryl groups play an important, but not exclusive, role in the x-ray inactivation of fructose-1,6-diphosphatase. The presence of AMP during irradiation protected the enzyme almost completely against inactivation of the allosteric function. Radioinactivation of the allosteric function of fructose-1,6-diphosphatase is evidently due to a specific modification of the binding sites for AMP. (BBB)

**29360** CELL POPULATION KINETICS OF THE ERYTHROID SYSTEM IN THE RAT: THE RESPONSE TO PROTRACTED ANEMIA AND TO CONTINUOUS $\gamma$ IRRADIATION. Tarbutt, R. G. (Inst. of Cancer Research, Belmont, Eng.). Brit. J. Haematol., 16: 9-24(Jan.-Feb. 1969).

Two stresses were employed (continuous $\gamma$ irradiation and weekly administration of the hemolytic agent phenylhydrazine hydrochloride) to study kinetics of erythropoiesis in rats. Male $F_1$ hybrid rats of the inbred August and Marshall strains were used, and the continuously irradiated rats were housed around a central $^{137}Cs$ source. Irradiation was started at the 6th week after birth, and continued for 10 weeks, at a mean dose rate of 43 rad/day. The inflow of cells to the proerythroblast compartment and the outflow of erythrocytes to the circulation were measured by $^{59}Fe$ autoradiography. In the anemic rats, the ratio of outflow to inflow was normal, indicating that the precursors undergo the normal number of divisions during maturation from proerythroblast to erythrocyte. In the continuously irradiated rats, the outflow was normal but inflow was decreased by a factor in the range 2 to 4, so that the ratio of outflow to inflow was increased by this factor, and the cells underwent more divisions than normal during maturation. Autoradiography with $^{3}H$-thymidine was used to determine cell proliferation parameters of the various maturation stages of the erythroid system in anemic rats. The number of divisions undergone during maturation through each stage was normal, but the maturation times and cycle times were considerably reduced. Less information was available on the proliferation parameters in the continuously irradiated rats, but the $^{59}Fe$ experiments indicated that the transit times of the proerythroblasts and of the non-dividing stages of the system are increased in response to this stress. (BBB)

**29361** LYSIS OF THE GRANULES OF BASOPHILS BY X RADIATION. Teixeira-Pinto, A. A. Compt. Rend. Soc. Biol., 162: 1870-2(1968). (In French).

X radiation of human leukocytes in vitro caused a lysis of the granules of the basophils the characteristics of which made it possible to determine cause/effect and dose/effect relationships. The phenomenon began immediately after the irradiation without a latent period. The effect increased progressively and after two hours the normal basophils were practically non-existent. (tr-auth)

**29362** CHANGES IN THE NEURONS OF THE RETINA IN RABBITS SUBJECTED TO THE EFFECTS OF IONIZING RADIATION. Ryzhnovskaya, S. A.; Bekchanov, A. N. (Astrakhan

Medical Inst., USSR). Radiobiologiya, 9: 307-9(1969). (In Russian).

It was shown in the work that x-irradiation of animals at a dose of 400 R produces changes in the nuclei metabolism both in the photoreceptors and in the ganglionic cells of the retina. (auth)

**29363** INFLUENCE OF RADIATION ON THE PROCESS OF SECRETION OF ADRENOCORTICOTROPIC HORMONE (ACTH) FROM THE ANTERIOR PITUITARY INTO THE BLOOD. Kharitonova, L. V.; Nevorotin, A. I. (Central Roentgenoradiological Scientific Research Inst., Leningrad). Radiobiologiya, 9: 316-18(1969). (In Russian).

X-irradiation of the head of rats leads to a disturbance of the secretion of ACTH from the pituitary into the peripheral blood and the accumulation of this hormone in the gland. Blockage of the secretion of ACTH is stable and is not eliminated under the influence of a nonspecific stimulus (cold). (auth)

**29364** THE ZINC CONTENT IN THE PANCREAS AND SUGAR CONTENT IN THE BLOOD OF RATS IN THE LONG-TERM PERIODS AFTER THE INFLUENCE OF IONIZING RADIATION. Fridlyand, I. B.; Ginzburg, M. B. (Roentgenoradiological Scientific Research Inst., Moscow). Radiobiologiya, 9: 321-3 (1969). (In Russian).

The zinc content in the pancreas of rats subjected to prolonged irradiation with low doses of ionizing radiation drops and remains at a low level (0.8 mg% as against 4.0 mg% in the control) in the long-term periods (six months) after the end of irradiation. In many cases, directly after the end of chronic irradiation with low doses of x rays, the drop in the zinc content in the pancreas is accompanied by an increased blood sugar level. The sugar content in the blood of rats in the long-term periods after the end of irradiation with low doses of x rays is within normal limits. (auth)

**29365** PRIMARY NATURE OF DAMAGE TO SUPERMOLECULAR DNA. Moiseenko, E. V. (Inst. of Biological Physics, Pushchino on the Oka, USSR). Radiobiologiya, 9: 177-82(1969). (In Russian).

The effects of radiation on the elastoviscosity of the supermolecular structure of DNA of loach sperm, isolated by a mild phenol method, were investigated. It was shown that incubation for 60 min at 37° of a sperm suspension irradiated at a dose of 1 kR does not intensify the radiation damage to the supermolecular structures of DNA, which is evidence of a primary, rather than an enzymatic nature of this damage. The DNA preparations obtained by treating loach sperm heads with trypsin were close in level of elastoviscosity and nature of radiation damage to preparations of supermolecular DNA obtained by the phenol method, which also confirms the primary nature of the damage to these structures. (auth)

**29366** MECHANISMS OF THE CHANGE IN THE PERMEABILITY OF THE MEMBRANE STRUCTURES OF THE CELL UNDER THE ACTION OF IONIZING RADIATION. Ozerskii, M. I. (Agrophysical Inst., Leningrad). Radiobiologiya, 9: 189-93(1969). (In Russian).

The modern concepts of the regulation of the ionic permeability of the outer membrane of animal and plant cells and the experimental data on the change in permeability, chiefly for $Na^+$ ions, under the action of ionizing radiation are discussed. It is proposed that one of the possible mechanisms of the action of radiation on the membrane structures of the cell may be inactivation of active transport of ions. (auth)

**29367** DYNAMICS OF THE SATURATION OF THE BLOOD AND ORGANS WITH ASCORBIC ACID AND RIBOFLAVIN DURING RADIATION SICKNESS. Egorova, N. D. (First Moscow Medical Inst.). Radiobiologiya, 9: 199-203(1969). (In Russian).

The metabolism of vitamins C and $B_2$ during radiation sickness was studied against a background of the use of milk-egg, meat, physiological, and laboratory diets. Vitamins were determined in the blood, liver, heart, spleen, kidneys, and adrenals. The data obtained permit a judgment of the normalizing influence of a milk-egg diet on the metabolism of vitamins C and $B_2$ in the process of development of radiation sickness. (auth)

**29368** DESTABILIZING AND DENATURING EFFECTS OF IONIZING RADIATION ON THE SECONDARY STRUCTURE OF DEOXYRIBONUCLEIC ACID. Ryabchenko, N. I.; Simonov, V. V.; Poverennyi, A. M. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 9: 171-6(1969). (In Russian).

The irradiation of DNA solutions at doses up to 10 krad leads to a sharp disruption of the stability of its secondary structure, whereas the formation of large denatured portions of DNA is detected only after 20 krad. It is hypothesized that the destabilizing effect of radiation is associated with the appearance of local denatured portions in the irradiated DNA, which are formed in sites of damage to the primary structure of DNA. (auth)

**29369** DISTURBANCE OF THE NEUROSECRETORY FUNCTION OF THE HYPOTHALAMUS DURING THE FIRST HOURS AFTER THE INFLUENCE OF IONIZING RADIATION. Smirnova, N. P.; Andrianova, L. A. (Inst. of Medicobiological Problems, Moscow). Radiobiologiya, 9: 194-8(1969). (In Russian).

The effects of stimulation of the hypothalamus with respect to neurosecretion of the supraoptical and paraventricular nuclei (by histochemical methods) and the antidiuretic activity of the blood plasma (by the method of biotesting) were studied in experiments on rats with electrodes implanted in the hypothalamus. These effects were compared with the vascular effect of stimulation of the hypothalamus. Three hours after total irradiation with the $\gamma$-rays of $^{60}Co$ at a dose of 400 R, the rabbits exhibited a disturbance of the mechanisms of neuroendocrine regulation. (auth)

**29370** COEFFICIENT OF RESPIRATORY CONTROL AND ULTRASTRUCTURE OF THE LIVER MITOCHONDRIA OF IRRADIATED RATS. Romantsev, E. F.; Kozyreva, E. V.; Mityushin, V. M. (Inst. of Biophysics, Moscow). Radiobiologiya, 9: 213-17(1969). (In Russian).

The coefficient of respiratory control, characterizing the functional state of the liver mitochondria of irradiated rats, was determined by a polarographic method. The ultrastructure of the organelles was studied simultaneously by an electron microscopic method. The functional state of the mitochondria after irradiation varies from strong coupling to loose 3 min, 30 min, and 3 hrs after the radiation influence. In this case, a calculation of the coefficient of respiratory control becomes impossible. After 30 min a change in the ultrastructure of the organelles is observed, correlated with the disturbance of processes of oxidative phosphorylation. (auth)

**29371** FUNCTIONAL STATE OF THE ADRENAL GLANDS UNDER THE COMBINED INFLUENCE OF THERMAL BURN AND TOTAL $\gamma$-IRRADIATION. Gubskii, V. I.; Pilipenko, N. I.; Brigadina, V. Ya. (Medical Inst., Kharkov. Scientific Research Inst. of General and Emergency Surgery, Kharkov). Radiobiologiya, 9: 223-7(1969). (In Russian).

The sorption properties of the adrenals with respect to a neutral dye, the permeability of the adrenal vessels to RISA, the level of 17-HCS and N-acetylneuraminic acid of the plasma, and the blood sugar level after $\gamma$-irradiation at doses of 400 and 800 R, application of thermal burn, and the combined influence of both factors were investigated in experiments on rats and guinea pigs. The results are evidence of a conservation of the functional reserves of the adrenals even in the terminal period of combined injury. (auth)

**29372** AUTORADIOGRAPHIC INVESTIGATION OF RNA SYNTHESIS DURING RESTORATION OF THE REGENERATIVE ABILITY OF THE LIMBS OF AXOLOTL, SUPPRESSED BY X-IRRADIATION. Tuchkova, S. Ya. (Inst. of Developmental Biology, Moscow). Radiobiologiya, 9: 183-9(1969). (In Russian).

RNA synthesis was studied by the method of radioautography following the incorporation of uridine-$^3H$ into the tissues of the limbs of axoloti after their x-irradiation at a dose of 6 kR and amputation and after irradiation, amputation, and injection of RNA, promoting a restoration of the regenerative ability suppressed by irradiation. A decrease in RNA synthesis in the subepithelial tissues of the irradiated limbs was detected after amputation. After the injection of high-polymer RNA, promoting a restoration of the regenerative ability of the limbs, suppressed by x-irradiation, there is a restoration of RNA synthesis in the subepithelial tissues of the limb. (auth)

**29373** CHANGE IN THE ACTIVITY OF CERTAIN OXIDATION-REDUCTION ENZYMES IN PLANTS WITH DIFFERENT RADIOSENSITVITIES. Seisebaev, A. T.; Babaeva, M. K. (Inst. of Biological Physics, Pushchino on the Oka, USSR. Inst. of Experimental Biology, Alma-Ata, USSR). Radiobiologiya, 9: 257-61(1969). (In Russian).

The influence of $\gamma$-irradiation on the nature of the change in the activity of the enzymes catalase, peroxidase, and cytochrome oxidase was investigated from the standpoint of the radiosensitivity of two species of plants from the legume family: radiosensitive—feed beans and radioresistant—red clover. It was found that irradiation of seeds at doses of 0.1 and 10 kR leads to an increase in the catalase and peroxidase activity in feed beans, while no changes were detected in clover. It is hypothesized that the different level of change in the catalase and peroxidase activities after irradiation of seeds is closely associated with the different radiosensitivities of the plants. (auth)

**29374** PRINCIPLES OF THE CHANGE IN THE ACTIVITY OF CERTAIN ENZYMES IN THE RAT LIVER IN THE CASE OF A SINGLE TOTAL IRRADIATION (HISTOENZYMOCHEMICAL INVESTIGATION). Kondrat'ev, V. S. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 9: 218-22(1969). (In Russian).

Using the method of histoenzymochemical investigation, the principles of the change in the activity of succinic dehydrogenase, NAD diaphorase, and alkaline phosphatase in the liver under the influence of ionizing radiation were determined. The intensity of the change in the activity of the respiratory enzymes and alkaline phosphatase in the liver depends on the irradiation dose and the time elaspsed after irradiation. The non-uniformity of the change in the activity of the investigated enzymes in the hepatocytes of different lobes is apparently associated with their different functional activities. After irradiation of rats at doses of 25 and 100 R, a restoration of the activity of the enzymes is observed by the 12th and 30th days, respectively. (auth)

**29375** SERUM ENZYME ACTIVITY DURING SPLIT-COURSE RADIOTHERAPY OF MALIGNANT TUMORS. Holsti, Lars R. (Univ. Central Hospital, Helsinki). Ann. Med. Inter. Fenn., 56: 189-93(1967).

Serum lactic dehydrogenase (LDH) and serum aldolase (ALD) were followed during radiotherapy in 125 cancer patients. The radiation therapy was given in the form of 33-MeV x rays or 20- to 34-MeV electrons, or $\gamma$ rays from a $^{60}$Co unit 6 times a week. Eighty four patients were treated with the split-course technique and 41 patients received radiotherapy continuously. The total tumor dose varied between 5000 and 6000 rad in 5 to 8 weeks; the daily tumor dose was 170 to 200 rad. A statistically significant decrease in serum LDH activity was observed in inoperable carcinoma of the lung from the beginning to the end of therapy. The changes found in the other tumor groups were not significant. No differences in enzyme activity were demonstrated between split-course and continuous therapy groups. Serum LDH seemed to reflect the regression of lung cancer during radiotherapy. In general, however, it seemed that LDH and ALD determinations during radiotherapy are not practical biochemical tests for assessing radiosensitivity and the response of cancers. (BBB)

**29376** EFFECT OF THE ULTRAVIOLET, ROENTGEN, AND GAMMA RAYS UPON SOME PHYSICO-CHEMICAL PROPERTIES OF A GLOBULIN PREPARATION ISOLATED FROM SUNFLOWER SEED. Svestarova, M.; Ivanova, D. (V. Kolarov Higher Agricultural Inst., Plovdiv, Bulgaria). Folia Med. (Plovdiv), 9: 130-8(1967).

A globulin extracted from sunflower seed by pH 7.0, 1M NaCl solution was irradiated in dilute solution (0.05%) by uv radiation (2537 Å), x rays (200 kV), and $^{60}$Co $\gamma$ rays. Doses of ionizing radiation up to 15 kR were given. The effects of irradiation at different pH values were determined by changes in the absorption in the uv band of the spectrum (220 to 320 nm). A diagram shows that the absorption maximum of the globulin at 280 nm is determined by the presence of tyrosine and tryptophan. A comparison between the spectrum of the globulin and the spectrum of its hydrolytic product was made. The spectra of nonirradiated solutions at various pH values and the pH effect upon absorption are shown. The absorption spectra of a nonirradiated solution and of an irradiated one with the three kind of radiations are illustrated. In all the cases, there was observed an increase of the absorption maxima in the range reflecting the aromatic amino acids. Such an effect was accounted for by the absorption of quanta to radiant energy that break hydrogen bonds leading to modification of the configuration of molecules. The modification is evident from the increase of the absorption maxima. The comparatively small doses of irradiation used, therefore, did not alter the primary structure of macromolecules. A dose of at least 5 Mrad was necessary to alter the primary structure. (BBB)

**29377** RAPID LOSS OF LABELED DNA FROM RAT BRAIN DUE TO RADIATION DAMAGE. Merits, Ilmar; Cain, John (Abbott Labs., Chicago). Biochim. Biophys. Acta, 174: 315-21(Jan. 21, 1969).

It was shown that an intracerebral injection of $^{3}$H-thymidine can cause radiobiological effects on brain cells seen as a loss of labeled DNA after extended duration of labeling. Intracerebral injection of 50 $\mu$Ci of $^{3}$H-thymidine into adult rats resulted in rapid incorporation of the label into brain DNA, with a peak of 6 to 8 hr. This was followed by an almost equally rapid disappearance of the newly formed radiative DNA with an initial apparent half-lifetime of 12 hr. During the loss of the radioactive DNA the amount of unlabeled DNA remained constant. It appears that incorporation of the highly labeled precursor into DNA, rather than its mere presence in the cell, is the prerequisite for the decay of the labeled DNA due to endogenous irradiation. Evidence that the mitochondrial DNA is less radioactive than the nuclear DNA is presented. (BBB)

**29378** EFFECT OF IRRADIATION ON THE CULTURED HUMAN LEUCOCYTES WITH SPECIAL REFERENCE TO THE SURVIVAL AFTER LARGE DOSES. Lindgren, I.; Raekallio, J. (Univ. of Turku, Finland). Beitr. Pathol. Anat. Allg. Pathol., 135: 427-35(1967).

Phytohemagglutinin blast cells cultured from healthy human peripheral leukocytes were exposed to $\gamma$ radiation from $^{60}$Co with doses varying from 100 to 60,000 rads. After a short-term culture of 68 to 72 hr the cells were studied using enzyme, histochemical, and cytological methods. The changes in nuclear structure could be observed after a dose of 200 rads and an incubation time of 24 hr. Histochemical demonstration of decrease as AS-esterase and cytochrome oxidase activity was evident as early as 24 hr after a dose of 20,000 rads. It is concluded that the phytohemagglutinin cell is resistant to radiation in its cytoplasmic activity, but sensitive in its nuclear activity. (auth)

**29379** ELECTRON SPIN RESONANCE INVESTIGATIONS OF RADIATION-INDUCED RADICALS IN BIOLOGICAL IMPORTANT SUBSTANCES. Moenig, H. (Univ., Freiburg i. B.). Atomkernenergie, 14: 61-4(Jan.-Feb. 1969). (In German).

Irradiation of biological substances leads to radical states that can be measured with the aid of electron spin resonance spectroscopy. It was shown that radicals could migrate within irradiated proteins. Therefore it was possible to influence the reaction of radiation at the physicochemical level. (auth)

**29380** EFFECT OF X-IRRADIATION ON THE CITRATE CONTENT IN MOUSE LIVER. Berndt, J. (Univ., Freiburg i. B.). Experientia, 25: 254-5(Mar. 15, 1969).

Following whole body irradiation with 690 R, normally fed mice show that the citrate content of the liver changes with food intake, while mice, subjected to 24 hour food withdrawal prior to radiation exhibit a constant citrate content throughout eleven days following radiation exposure; thereafter, it increases. The results are discussed especially with respect to acetyl-CoA-synthetase and phosphofructokinase. (H.B.G.)

**29381** PHYSIOLOGY OF THE LARGE MILKWEED BUG AFTER LASER IRRADIATION. Feir, Dorothy; Lough, John Wm. Jr. (St. Louis Univ.). Comp. Biochem. Physiol., 28: 759-64(Feb. 1969).

The whole-body oxygen consumption, hemolymph protein concentration, uric acid concentration in the excreta, and whole-body ATP concentration of the large milkweed bug, Oncopeltus fasciatus, was determined after ruby laser irradiation (6943 Å). Energy levels ranged from 0.4 to 0.6 J/pulse and the pulse duration was 10 to 12 nsec. The irradiation was focused with simple lenses to a beam width of ~0.5 mm dia and the insect was placed 1 mm behind this focused point. Irradiation caused a significant decrease in the oxygen uptake on the first 2 days of the fifth stadium. A decrease in the hemolymph protein concentration was found in treated insects on the fourth day of the stadium. Irradiation apparently had no effect on the uric acid content of the excrement. There was a decrease in whole-body ATP content on the first day of the stadium and an increase over the control values on days 2, 5, and 9. The decrease in the amount of whole-body ATP in first day post-molt probably reflected the decreased respiration observed in lased animals of the same age. However, on the second day post molt, respiration was again decreased by the irradiation, but whole-body ATP concentration was significantly higher. Possibly on the second day of the stadium the enzyme ATPase may have been inactivated by the irradiation which led to an increase in whole-body ATP. (BBB)

**29382** X- AND $\gamma$-IRRADIATION OF DILUTE SOLUTIONS OF CHYMOTRYPSIN: THE ACTIVE INTERMEDIATE. Lynn, K. R.; Orpen, Gail (Chalk River Nuclear Labs., Ontario). Int. J. Radiat. Biol., 14: 363-71(1968).

X and $\gamma$ irradiation of dilute aqueous solutions of chymotrypsin in $10^{-3}$ M HCl or in water produced difference spectra, over the range 210 to 330 m$\mu$, qualitatively similar to that obtained on reaction of the enzyme with hydroxyl radicals from Fenton's reagent. The protection of the esterolytic properties of chymotrypsin against irradiation was measured using benzoyl tyrosine ethyl ester (BTEE) as the substrate and sodium formate, acetone, glucose, ethanol, and iso-propanol as protectors. The results, when combined with absolute rate constants available for reactions of the hydroxyl radical, showed that radical to be the predominant reactive species in the irradiation of dilute aqueous solutions of the enzyme. (auth)

**29383** THE PERCENTILE FREQUENCY OF THE IMMEDIATELY ADJACENT NUCLEOTIDES IN DATURA RNA AFTER AN X IRRADIATION. Brucker, W.; Rodhe, R. G. (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Ber. Deut. Bot. Ges., 81: 252-62 (Oct. 24, 1968). (In German).

Alterations in nucleotide pairs of crown gall tissues from Datura innoxia were studied by means of $^{32}P$ incorporation after x irradiation with a dose of 3 KR. The % frequency of 2', 3'- and 5'-nucleotides in adjacent pairs was measured. The differences between the separate nucleotide activities decreased with increasing $^{32}P$ incubation times. The frequency of the cytidine-guanosine phosphate pair (CpG) was 12%, and for the pairs adenosine-cytidine phosphate (ApC), adenosine-uridine phosphate (ApU), and cytidine-cytidine phosphate the frequencies were 3%. The % frequencies of 12 other possible adjacent pairs were from 4 to 10%. The amounts of nucleotides were not altered by irradiation prior to $^{32}P$ treatment, but incorporation of the $^{32}P$ was decreased, depending on the nucleotide. Evaluation of frequencies of appearance of adjacent nucleotides indicated that irradiation caused a decrease in the CpG fraction to 9% and an increase of guanosine-cytidine phosphate (GpC) from 8 to 12%. Only small differences were observed in the frequencies of other nucleotide pairs. (BBB)

**29384** X-RAY INACTIVATION OF PHOSPHOFRUCTOKINASE: THE RELATIVE RADIATION SENSITIVITY OF THE CATALYTIC AND THE ALLOSTERIC PROPERTIES. Chapman, A.; Sanner, T.; Pihl, A. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Biochim. Biophys. Acta, 178: 74-82(Mar. 18, 1969).

The relative roles of sulfhydryl group inactivation and changes in allosteric activity induced by radiation in the inactivation of an enzyme were studied by x irradiating rabbit muscle phosphofructokinase in solution. Phosphofructokinase is a key enzyme in the regulation of glycolysis, and blocking of its sulfhydryl groups has no effect on the allosteric properties of the enzyme. The dose response curve for the loss of catalytic activity was biphasic, indicating that the enzyme consists of two fractions of widely differing radiosensitivity. Sucrose gradient studies indicated that the resistant fraction was associated with high molecular weight aggregates of the enzyme. The sensitive fraction was inactivated with a G value of 0.055. Measurements of the disappearance of SH groups upon irradiation and of the protective effect of p-chloromercuribenzoate blocking prior to irradiation indicated that destruction of SH groups plays an important role in the radiation-induced loss of the catalytic activity. The allosteric activity, as measured by the ability of adenosine monophosphate to reverse the adenosine triphosphate (ATP) inhibition of the enzyme, was relatively resistant to radiation inactivation. Loss of allosteric activity did not occur until a considerable threshold dose had been accumulated. The shape of the dose-response curve could be explained by the radioinduced changes in kinetic parameters. It was shown that the radiation-induced decrease in allosteric activity was due to a reduced sensitivity to ATP inhibition in the irradiated enzyme. (BBB)

**29385** NEUTRON IRRADIATION OF TACHOSTYPTAN AND EPSILON-TACHOSTYPTAN. Szirmai, Endre A.; Berthoty, Laszlo v.; Speidel, Volker; Keinert, Juergen; Knapp, Juergen; Hehn, Gotfried (Univ., Stuttgart). Strahlentherapie, 137: 122-4(Jan. 1969). (In German).

Tachostyptan and Epsilon-tachostyptan were irradiated with neutrons in the Siemens Teaching Reactor S.U.R. 100. The activity and dose rate were measured. The results show that the preparation does not contain any unwanted high activity or dose rate value. (auth)

**29386** LYSOZYMES: A CHAPTER OF MOLECULAR BIOLOGY. Jolles, P. (Univ., Paris). Angew. Chem. Int. Ed. Engl., 8: 227-39(Apr. 1969).

Hen egg-white lysozyme was the first enzyme whose tertiary structure could be elucidated. The peptide chain of this enzyme is arranged in two sections, of approximately equal size, that are separated by a deep cleft. Substrates (and inhibitors) are bound in this cleft via hydrogen bonds and are hydrolyzed under the action of Glu 35 and Asp 52, which form the active site of the enzyme. Although, the lysozymes, which occur in many species of animals and plants, exhibit differences in their chemical behavior, they have the same qualitative biological activity; quantitatively important differences were noted that also concern the specificity. Infection of E. coli with bacteriophages gives rise to a lysozyme whose formation is controlled by the phage DNA. The fact that mutated lysozymes are produced when the phages are treated with mutagens opens new fields of research in molecular biology. (auth)

**29387** EFFECT OF LARGE DOSES OF RADIOIODINE ON THYROID FUNCTION. IV. IODOPROTEINS IN BLOOD. Jovanovic, M.; Djurdjevic, Dj.; Sinadinovic, J.; Krajcanic, M. (Inst. for the Application of Nuclear Energy in Agriculture, Veterinary Medicine, and Forestry, Belgrade). Acta Endocrinol., 60: 287-93(Feb. 1969).

When rats were administered large doses of radioiodine (150 $\mu$Ci $^{131}I$/100 g body wt), a highly iodinated protein appeared in blood. This protein, also found in pathologic states in humans, was investigated. Separation and identification of this iodoprotein were performed by gel filtration and by sucrose density gradient and analytical ultracentrifugation. It was established that this iodoprotein in the blood represents 19S thyroglobulin that is secreted by the thyroid gland damaged by the large dose of radiation. In rats treated with $^{131}I$, thyroglobulin was found in the blood 24 hr after the administration of the radioisotope. The concentration increased up to the fifth day and then decreased, while on the 11th day the thyroglobulin could no longer be detected. The dynamics of the appearance of the thyroglobulin and its concentration in the blood serum could be used as an indicator of the radiation effect of high doses of radioiodine, both in experimental conditions and in therapeutic medicine. (BBB)

**29388** EFFECT OF LARGE DOSES OF RADIOIODINE ON THYROID FUNCTION. III. THE IODOPROTEINS OF THE THYROID GLAND. Djurdjevic, Dj.; Jovanovic, M.; Krajcanic, M.; Sinadinovic, J. (Inst. for the Application of Nuclear Energy in Agriculture, Belgrade). Acta Endocrinol., 60: 281-6(Feb. 1969).

The effect of a large dose of radioiodine (150 $\mu$Ci/100 g) on the soluble proteins in the thyroid glands of rats was investigated. The average dose of radiation absorbed by the thyroid gland of animals treated with this dose of $^{131}I$ was, after 1 day, 52,300 rep; after 3 days, 144,081 rep; after 4 days, 166,911 rep; and after 5 days, 180,464 rep. At later time intervals the absorbed amount of radiation increased very little because of the low content of radioiodine in the gland. Up to the fourth day no effect of radiation from $^{131}I$ was observed on either the total quantity of soluble proteins or relative amounts of fractions 19S and three to 8S in the gland. Later, a progressive decrease of fraction 19S occurred with a parallel increase in fraction three to 8S. At 13 days, the quantity of 19S thyroglobulin/100 mg of tissue was 14% of the value found on the first day. At the same time the total amount of extracted soluble proteins decreased to about 50% of the initial value. These changes were explained: (1) by transfer of thyroglobulin from the damaged follicles into the circulation; (2) by a decrease of thyroglobulin synthesis; and (3) by inhibition of the polymerization of protein fractions that are the precursors of thyroglobulin. (BBB)

**29389** EFFECT OF AN EXTRACT OF UV-IRRADIATED LINOLENIC ACID ON AZO DYE CARCINOGENESIS. Mulay, A. S.; O'Gara, R. W.; Anderson, H. J.; Saslaw, L. D.; Waravdekar, V. S. (National Cancer Inst., Bethesda, Md. Armed Forces Inst. of Pathology, Washington, D. C.). Cancer Res., 29: 373-9 (Feb. 1969).

One to four intraperitoneal injections of water extract of uv-irradiated linolenic acid were given to male Osborne-Mendel rats. Injections were at monthly intervals with graded doses (120 to 600 thiobarbituric acid units/kg/dose) of the extract. Some of these rats received a subcarcinogenic dose (0.12%) of p-dimethylaminoazobenzene (DAB) in powdered Purina chow diet from the day of first injection for four months. The experiments were terminated two months later. Four hundred units or more of uv-irradiated extract alone were lethal within 72 hrs, lower dosage of the uv-irradiated extract produced chronic toxicity, with swelling of the liver, fusion of its lobes, and adhesions to surrounding structures. DAB in the diet for 4 months and three or four injections of uv-irradiated extensive cholangeofibrosis of the liver in all the animals and hepatoma nodules in 25% of the rats. Activity of some oxidases, dehydrogenases, and phosphatases of the livers of these rats was 25 to 40% lower than that of the comparable enzymes in control rats. (auth)

## Immunology

*Refer also to abstracts 29585 and 29723.*

**29390** (ACRH-30, pp 1-7) IN VITRO BEHAVIOR OF STEM CELLS. Krantz, S. B.; Fried, W. (Argonne Cancer Research Hospital, Chicago, Ill.).

A modification of an in vitro cell culture system in which rat bone marrow responds to the addition of erythropoietin with a marked increase in the rate of hemoglobin synthesis is described. This modified method was used for simultaneous measurements of the ability of cultured mouse spleen cells to respond to erythropoietin in vitro and to form spleen colonies when transplanted into lethally irradiated mice. Iron-59 was used to measure the rate of heme synthesis and to detect formation of spleen colonies. Experiments on the effects of erythropoietin on heme synthesis by mouse spleen cells in vitro revealed a continuous decline in

the ability of the cells to respond to erythropoietin with increased heme synthesis. Erythropoietin was found to exert no effect on the total number of colony-forming units (CFU) produced from mouse spleen cells treated in vitro. Mice exposed to 800 R of x radiation were injected with in vitro erythropoietin-treated spleen cells and it was observed that the incubation of CFU in the presence of erythropoietin did not affect the rate of erythropoiesis in the resulting colonies. The role of erythropoietin in erythropoietic cell cycles and metabolism is discussed. (C.O.)

**29391** (ACRH–30, pp 38–48) DEVELOPMENT OF RESPONSE TO ERYTHROPOIETIN AND REPLETION OF THE STEM CELL COMPARTMENT AFTER IRRADIATION. DeGowin, R. L.; Johnson, S. (Argonne Cancer Research Hospital, Chicago, Ill.).

Results are presented for experiments designed to investigate the role of erythropoietin in the postirradiation recovery of erythropoiesis and to compare the erythropoietic response of repopulating bone marrow cells in the spleen with those cells remaining in the shielded femur. It was shown that levels of erythropoietin capable of increasing erythropoiesis in the shielded femur to twice normal during the first four days after x irradiation failed to increase erythroid differentiation in the colonized spleen. Why hematopoietic cells in the colonized spleen appear relatively refractory to erythropoietin during the first four days after mice received 850 R with the leg shielded is discussed. (C.O.)

**29392** (ACRH–30, pp 58–64) STUDIES ON THE KINETICS AND RADIATION SENSITIVITY OF DENDRITIC MACROPHAGES. Hunter, R. L.; Wissler, R. W.; Fitch, F. W. (Argonne Cancer Research Hospital, Chicago, Ill.).

The process by which material is taken into dendritic macrophages of the rat spleen, the effects of x radiation on this process, and the relation between the amount of antigen retained by the dendritic macrophages and the peak titer of antibody produced were studied. Animals were injected with either a saline suspension of $^{125}$I-labeled flagella (antigen) or titanium dioxide; bacterial agglutination titers were determined and histological examinations were made. The pathway by which material entered the dendritic macrophages is described. Results supported the evidence that the small fraction of antigen retained by the macrophages played an important role in the stimulation or maintenance of IgG antibody production. Results also indicated that only the uptake of material by the dendritic macrophages was radiosensitive; once particles were transported, they were not rapidly displaced by sublethal doses of x radiation. It was suggested that the radiosensitivity of the transport material to the dendritic macrophages was due to radiation damage to stationary elements of the lymphoid follicle. (C.O.)

**29393** (COO–1210–45) THE EFFECTS OF IRRADIATION ON ERYTHROCYTE CHIMERISM AND IMMUNOLOGIC TOLERANCE IN CATTLE TWINS. Annual Technical Progress Report VII, March 15, 1968–March 15, 1969. Stone, William H. (Wisconsin Univ., Madison. Lab. of Genetics. UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.). Contract AT(11-1)-1210. 21p. Dep. CFSTI.

Fractionated doses (25 to 50 R/week) of whole-body $^{60}$Co $\gamma$ radiation appeared to regularly cause shifts in the proportions of the two antigenic cell types in chimeric twin cattle. Repeated observations on 23 twins (9 pairs and 5 unpaired) that received single doses indicated that once a shift had occurred, the new equilibrium between the two cell types (hematopoietic tissues) was relatively stable. Transplanted kidneys did not appear to cause shifts in red cell proportions. Co-twin skin grafts were studied in 61 chimeric animals during a period of 268 weeks; 21 animals died during this time and among those that died 14 had already rejected grafts. A total of 12 chimeric co-twin kidney transplants were made. Of the 8 surviving animals, 5 possess grafted kidneys that function well. The effects of heteroimmune (rabbit) anti-bovine thymus-tissue antibodies on the proportion of the two cell types in chimeric twins was studied. Differential hemolysis tests for 28 weeks following these injections did not show any significant changes in the proportion of the two cell types. An attempt to produce chimeras by transplanting tissues into developing fetuses resulted in two of the 12 recipients aborting; the remaining 10 are nearing the mid-point of gestation. Four $\gamma$-irradiated calves (900 R dose) were injected with nucleated marrow cells and lived 7 to 9 days postirradiation; death was attributed to hematopoietic difficulties. There was no indication of chimerism before death. Phylogenetic analysis of cattle using immunogenetic parameters provided some insight into historically obscure relations of domestic cattle breeds. A list of the publications (7) that evolved during the research year is included. (C.O.)

**29394** (EUR–4093) RESEARCH ON THE DIFFERENTIATION OF IMMUNOLOGICALLY COMPETENT CELLS. Annual Report, 1967. Doria, G. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari). Dec. 1968. 14p. (In Italian). Dep.

Progress is reported on research work centered on the following problems: the role of the thymus in the differentiation of the precursors of antibody-forming cells transplanted in irradiated animals; the relation between antibody formation and erythropoiesis of hemopoietic tissues transplanted in irradiated animals; and the differentiation of immunologically competent cells in vitro. (auth)

**29395** (ORO–3511–11) QUANTITATIVE STUDIES ON THE EFFECTS OF RADIATION ON VIRUS-HOST SYSTEMS AND THE IMMUNE RESPONSE. Galasso, G. J. (Virginia Univ., Charlottesville. Dept. of Microbiology). [1968]. 6p. Dep. CFSTI.

The effects of uv and x radiation on the rate of growth of vesicular stomatitis virus (VSV) in L cells were studied. Immune reactions in rabbits infected with VSV or vaccinia virus were also studied. Biological properties of VSV virus, such as adsorption, penetration, replication, effects of temperature, and release of the virus are discussed. Methods were developed for obtaining a one to one ratio of viron to plague forming unit in L cells. Exposure of the VSV virus-host model to uv radiation induced a decrease in virus infectivity within 90 seconds and all attempts to show multiplicity reactivation were negative. When x-irradiated (30,000 R) solutions of phosphate buffered saline were used as a diluent for VSV viruses there was at least a one log drop in infectivity. Possible explanations are discussed. Serial passage of vaccinia virus in L cells induced a change in pathogenicity of the virus for rabbits. An extremely active antiserum to VSV virus was prepared in rabbits and the effect of the antiserum on the virus was studied, using the precipitin-in-gel double diffusion technique. (C.H.)

**29396** (UCRL–18347, pp 99–111) STUDIES OF STEM CELL KINETICS UTILIZING THE SPLEEN COLONY TECHNIQUE AND THE ERYTHROPOIETIN SENSITIVITY TEST. Schooley, John C. (California Univ., Berkeley).

Evidence is presented consistent with the view that the production of erythroid cells in spleen colonies depends on the presence of erythropoietin; however, the hormone does not act directly on the colony-forming cell. The colony-forming cell gives rise to a population of cells which is sensitive to erythropoietin. Erythropoietin regulates the differentiation of such cells by a DNA-dependent-RNA synthetic step. The erythropoietin-sensitive cells are capable of division and their proliferation as well as their formation from colony-forming cells is regulated. (auth)

**29397** (UCRL–50492) THE ROLE OF THE IMMUNE SYSTEM IN CANCER: A SPECULATIVE REVIEW. Wilbur, David W. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 4, 1968. 71p. Dep. CFSTI.

Information was gathered from a wide variety of investigations that seem to have some relation to the title topic. This information was organized in an attempt to show the ways in which the immune system may relate to cancer initiation, growth and regression, with special emphasis on the possibilities for the therapy of human cancer. Reasons for expecting cancer cells to have abnormal antigens are presented, and there is a review of the experimental evidence for such antigens in the tumors of isogenic animal strains and of humans. The possibility that the same cancer-specific antigens may appear in different tumors has great therapeutic and prophylactic importance, hence a section is devoted to discussion of the evidence on this point. If there are specific abnormal antigens in tumors, tumor-incidence patterns might reflect the status of the immune system; therefore information on this point is reviewed. There is also a section summarizing evidence for antitumor activity (often ineffective) by the immune system during the establishment and the growth of tumors. Since cures of cancer do occur after standard therapeutic measures, the possible role and probable importance of the immune system in these is discussed. Furthermore there is a review of the evidence concerning the role (probably central) of the immune system in the spontaneous regression and remission of cancer. Some space is devoted to a discussion of the possibility that certain little understood and unconventional antitumor regimes may act via immune mechanisms. The last part of the paper is devoted mainly to a review of the various possibilities for exploiting immunological methods in cancer therapy and the recent work attempting to use these procedures. Included are discussions of antibody transfer, immune cell transfer, and stimulation of the host reaction by various means. Also presented is a brief review of the possibilities for using the immune system in prophylaxis of cancer. (auth)

**29398** TRANSPLANTED RAT HEART: LOCAL GRAFT IRRADIATION. Ono, Keiji; Lindsey, Edward S.; Creech, Oscar Jr.

(Tulane Univ., New Orleans). Transplantation, 7: 176-82(Mar. 1969).

The effect of local graft x irradiation on the function of heterotopically transplanted heart was studied in rats. Lewis strain rats received abdominal heart transplants from donors of the Buffalo strain. After transplantation, recipients were randomly assigned to one of two groups: group I received six doses of 150 R each, delivered only to the graft area, and group II remained untreated. The mean duration of function differed significantly for untreated grafts (9.9 days) and irradiated grafts (14.7 days). Lymphocytic infiltration was delayed in irradiated hearts. (auth)

**29399** EFFECTS OF ANTITHYROID THERAPY ON THE LONG-ACTING THYROID STIMULATOR AND THE ANTITHYROGLOBULIN ANTIBODIES. Pinchera, A. (Univ., Rome. Univ., Pisa, Italy); Liberti, P.; Martino, E.; Fenzi, G. F.; Grasso, L.; Rovis, L.; Baschieri, L.; Doria, G. J. Clin. Endocrinol. Metab., 29: 231-8(Feb. 1969).

Evidence indicating that the long-acting thyroid stimulator (LATS) is involved in the pathogenesis of Graves' disease (goiter) and the hypothesis that LATS is an antibody to a thyroid antigen are reviewed. Serial tests for long-acting thyroid stimulator (LATS) and antithyroglobulin antibodies were performed in 32 patients with toxic diffuse goiter submitted to $^{131}I$ therapy and in 29 patients receiving an antithyroid drug (methimazole). The level of detectable LATS and the incidence of positive assays tended to increase transiently following $^{131}I$ therapy and to decrease during the administration of antithyroid drugs. Statistical analysis of the LATS changes detected at the time interval of 46 to 180 days after treatment showed that the differences between the two therapeutic groups were significant. A transient rise of circulating antithyroglobulin antibodies occurred in several patients treated with radioiodine, but individual changes showed no parallelism with the course of LATS. No definite pattern was noted in the behavior of antithyroglobulin antibodies during the administration of antithyroid drugs. Twenty-six patients with toxic adenoma previously treated with radioiodine and 26 untreated controls were tested for LATS and all of them had negative assays. The possibility that thiocarbamides interfere with the immune response was investigated in mice immunized with sheep red blood cells. No immunosuppressive effect of methimazole was found. The implications of these findings are discussed. (auth)

**29400** LYMPHATIC SYSTEM AND ORGAN TRANSPLANTATION. Malek, P.; Vrubel, J. (Inst. for Clinical and Experimental Surgery, Prague). Lymphology (Stuttgart), 1: 4-22(Mar. 1968).

Use of ionizing radiations and other immunosuppressive agents in organ transplantation is considered in a review of the role of the lymphatic system in the rejection phenomenon. Immunosuppressive chemotherapy is sometimes supplemented by local ionizing irradiation. The effect of extracorporeal irradiation of the thoracic duct lymph upon skin transplant survival has been examined in calves. The observation is stressed that irradiation of the thoracic duct lymph produced a prolongation of the survival of these grafts draining primarily into the thoracic duct, while grafts placed in sites not drained by the thoracic duct remained functional for a shorter period of time. Results obtained by the injection of radioactive substances into the lymphatic system are also mentioned. Substances used included $^{198}Au$, $^{206}Bi$, $^{111}Ag$, $^{90}Y$, chelated with DTPA, colloidal chromic phosphate with $^{32}P$, and Ethiodol-$^{131}I$. These radioactive substances were injected into lymph vessels or nodes, or they were indirectly administered into subcutaneous draining regions. Effects were no better than with classical immunosuppression. However, there may be some potential in the method since it was possible to demonstrate considerably prolonged homograft survival in a dog that was injected with radiogold into the lymph vessels of the legs and into the mesenteric lymph nodes. (BBB)

**29401** EXPERIMENTAL STUDIES ON THE MECHANISM OF AN INCOMPLETE ANTIBODY FORMATION. EFFECTS OF X-RAYS ON AN INCOMPLETE ANTIBODY FORMATION IN RABBITS INJECTED WITH ANTIERYTHROCYTE SERUM. Miyoshi, Hiroshi (Osaka City Univ.). Arerugi, 16: 832-42(Dec. 1967).

Following a single intravenous injection of a small amount (1.0 ml/kg) of antirabbit erythrocyte guinea pig serum as antigen, most rabbits developed in five to ten days into a typical hemolytic anemia with a severe hyperchromic anemia, reticulocytosis, and an increased osmotic fragility of red blood cells, resulting in positive direct and indirect antiglobulin tests. Following whole-body x irradiation of 600 roentgens given at various periods before or after injection of the antigen to rabbits, a complete antibody formation against the heterologous antigen was markedly suppressed, but an incomplete antibody formation against autoerythrocytes was not suppressed, when irradiation was applied 24 to 48 hrs before injection of the antigen. In a group irradiated 72 to 96 hrs after injection of the antigen, incomplete antibody formation against autoerythrocytes was significantly suppressed. It was concluded that an incomplete antibody production against autoerythrocytes was quite different in mechanism from a complete antibody production against heterologous protein. (auth)

**29402** CUTANEOUS REACTIONS IN MICE INJECTED INTRADERMALLY WITH CELLS FROM HEAVILY IRRADIATED SYNGENEIC DONORS. Allegretti, N. (Univ., Zagreb); Dekaris, D. Transplantation, 7: 215-18(Mar. 1969).

Reactions in the skin of mice following the injection of spleen cells from donors exposed to doses of 500 or 950 R x radiation were tested using the distribution of injected Evans blue solution as the test. No skin reactions were observed following the injection of spleen cells from 500 R irradiated mice or when 950 R irradiation was applied 24 hr prior to the cell transfer. However, a pronounced skin reaction was seen in mice injected with spleen cells from syngenic donors exposed to 950 R seven days before the cell transfer. Possible immune reactions involved are discussed. (C.H.)

**29403** TRIAL INTERFERON PRODUCTION BY CHICK EMBRYO CELLS IN OVO AND IN VITRO UNDER THE INFLUENCE OF LIVE OR INACTIVATED NEWCASTLE DISEASE VIRUS. German, A.; Panouse-Perrin, J.; Quero, A. M. (Faculte de Pharmacie, Paris). Ann. Inst. Pasteur., 114: 217-35(Feb. 1968). (In French).

A comparison was made of the ability of native and uv irradiated Newcastle disease virus to induce interferon production in chick embryo cells. Inactivation of the virus by uv irradiation (2537 Å) was studied. Irradiation of the virus for 20 sec by a Philips TUV lamp at a distance of 13 cm gave the best inactivated product. Electron microscopy showed a heterogenous virus population, with filamentous and spherical forms, some of which may have been more sensitive to uv. The production of interferon was studied and compared for virulent and uv-inactivated viruses in incubated hen eggs and in monolayers of fibroblasts of chick embryo. In incubated hen eggs, the formation of interferon was related to the development of pathogenic viruses causing the death of the embryo. In the case of cells, the irradiated viruses were better inducers of interferon than the virulent viruses. In both cases, it seemed that the production of interferon by the cells resulted only from a massive infection of viruses either virulent or inactivated in nature. (BBB)

**29404** ANTIBODY FORMATION IN RADIATION CHIMAERAS. Zaretskaya, Yulia M.; Panteleev, E. I.; Kovalchuk, L. V. (Inst. of Biophysics, Moscow). Folia Biol. (Prague), 14: 386-9(1968).

The recovery of antibody synthesis in syngeneic CBA mouse radiation chimeras was observed for 100 days after $\gamma$ irradiation. The reaction to sheep and rat red blood cells was observed in parallel experiments. It was found that both the primary and the secondary reaction to rat red blood cells did not recover for three months. (auth)

**29405** A RAPID METHOD FOR CHECKING THE PURITY OF RADIOIODINATED HUMAN LUTEINIZING HORMONE. Abraham, Guy E. (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). Clin. Chem., 15: 230-6(Mar. 1969).

A method using dextran-coated charcoal was developed to check the purity of radioiodinated human luteinizing hormone (HLH). The labeled forms of the peptide hormone were obtained by radioiodination with $^{125}I$ or $^{131}I$, using the method of Greenwood, to obtain specific activities of 175 to 250 $\mu$Ci/$\mu$g using $^{125}I$ and 300 to 600 $\mu$Ci/$\mu$g using $^{131}I$. The results obtained by the method described compared favorably with those obtained by the double antibody technic, which takes much longer to perform. The reliability of the method using dextran-coated charcoal (DCC) is demonstrated and its practicability discussed. Using the DCC method, some comparative studies were done with $^{125}I$- and $^{131}I$-labeled HLH. The degree of damage to the labeled HLH, in relation to time after iodination, was greater when $^{131}I$ was used for iodination, although a greater release of inorganic radioactive iodide was observed with $^{125}I$. The $^{125}I$-HLH could be used in the radioimmunoassay for as long as 2 weeks after iodination, whereas $^{131}I$-HLH was usable only for 3 days after iodination, taking 70% as the lower limit of undamaged labeled HLH acceptable for use in the assay. With $^{125}I$-HLH, most of the radioactivity which could not be adsorbed by the DCC method was found to be in the inorganic peak when rechromatographed on Sephadex G-75, using phosphate buffer (0.01 M) at pH 7.8 as eluant. Because of this finding and the longer half-life of $^{125}I$ (60 days compared to 8 days for $^{131}I$), $^{125}I$ is now used routinely for radioiodination. The fractions with the least damage were found consistently to be the ones following the peak fraction. (BBB)

**29406** IMMUNOLOGICAL STATUS OF THE LYMPHOMAS. Aisenberg, Alan C. (Harvard Medical School, Boston. Massachusetts General Hospital, Boston). pp 373-83 of Proceedings of the International Conference on Leukemia-Lymphoma, Ann Arbor, Michigan, October 9-13, 1967. Zarafonetis, Chris J. D. (ed.). Philadelphia, Lea and Febiger, 1968.

See CONF-671073.

The immunological deficiency in Hodgkin's disease is particularly severe and infectious complications are difficult. Aspects of this deficiency reviewed are the role of the cellular type of immunological response, the loss of immunological sensitivities and the inability to acquire new ones, the significance of the homograft reaction, lymphocyte count and function, and phagocytic function. Lymphosarcomas are also discussed. The effects of treatment that is immunosuppressive (x radiation, drugs) is considered. (C.O.)

**29407** DYNAMICS OF THE APPEARANCE OF INCOMPLETE ANTIBODIES DETECTED BY THE COMBS TEST IN SINGLY AND REPEATEDLY IRRADIATED ANIMALS. Ivanov, A. A. (Inst. of Biophysics, Moscow). Radiobiologiya, 9: 324-5(1969). (In Russian).

It was established in the work that the direct Combs test is recorded from the second week after the first irradiation, reaches a maximum degree of expression by the 23rd to 30th day, and remains positive for a long time. In repeatedly irradiated radiation reconvalescents, the Combs test is already intensified in examination on the third day after irradiation and reaches a maximum earlier, by the 20th day. (auth)

**29408** INFLUENCE OF SINGLE AND DOUBLE IRRADIATION OF ANIMALS ON THE RESPONSE OF COMPLEMENT FIXATION AND THE COMPLEMENTARY FUNCTION OF BLOOD SERUM. Ivanov, A. A. (Inst. of Biophysics, Moscow). Radiobiologiya, 9: 232-5(1969). (In Russian).

Samples of serum from 42 mongrel dogs, irradiated with $\gamma$-rays at a dose of 600 R, were investigated by the reaction of complement fixation. The reaction of complement fixation is distinctly manifested on the 14th to 18th days after primary irradiation and is normalized in the period of reconvalescence. The intensity of the response in the case of repeated irradiation of the animals is considerably higher, and positive reactions are already noted on the second day after irradiation. The complementary function of the blood serum of irradiated animals changes in phases: it increases during the latent period, drops below normal in the second half of the period of pronounced clinical manifestations, and is normalized during the period of reconvalescence. (auth)

**29409** EFFECT OF IONIZING RADIATION ON TUMOR IMMUNITY. 2. ROLES OF THE SPLEEN AND THE LYMPH NODE CELLS. Nitbe, Hideo; Tobe, Tatsuo (Gumma Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 28: 160-8(May 1968). (In Japanese).

The mechanisms of radiation effects on immune reactions to transplants of Yoshida sarcoma in immune male Wistar-strain rats were studied. The radiosensitivities of different kinds of cells that were considered to produce antibody were examined. The results showed that when immune rats were x irradiated with a dose of 500 R on the lower half of the body containing the spleen the antitumor activity was lost, but when the upper half of the body was irradiated, or the whole body was irradiated with the spleen protected, the resistance remained. On the other hand, the resistance was not lost by irradiation on the left part of the lower half of body, exclusive irradiation of the spleen, or splenectomy. The lymphoreticulocyte system was found to play the principal role in transplantation immunity. The majority of the cells were damaged by 500 R radiation, and it took several weeks for them to be restored. Mature plasmocytes and macrophages were relatively resistant to irradiation, and their marked changes were not observed even after irradiation with 500 R. The lymph node and spleen cells of immune rats caused a reduction in the proliferative ability of Yoshida sarcoma cells in vitro, but when these cells were irradiated with 500 R, they were damaged and the antitumor activity vanished concurrently. It was concluded that the lymph node and spleen cells have an intimate relation with cellular antibody production. (NSA of Japan) (TSS)

**29410** MYELOID RESPONSE TO MARROW TRANSPLANTATION IN LETHALLY-IRRADIATED MICE. Da Costa, J. C. (Wadia Maternity Hospital, Bombay); Da Costa, H. J. Indian J. Med. Sci., 21: 661-5(Oct. 1967).

The effects of prior administration of blood and tissue cells on the success of a subsequent transplant of bone marrow and tissue cells obtained from the same donors in therapeutically x-irradiated mice were investigated. Death of the animal was used as a criterion for assessing the success of the graft. The myeloid status at the time of death was assessed from a histological examination of the femur, spleen, and lymph node to determine whether any correlation existed between the myeloid response, the experimental procedure, and the period of survival of the animal. Clear-cut conclusions drawn were as follows: Homologous bone marrow transplants prolonged life significantly in mice exposed to otherwise lethal irradiation. Prior antigenic stimulation adversely affected the protective effects of the bone marrow transplant. The myeloid response as studied in the femoral bone showed a fairly consistent pattern and was not affected by prior antigenic stimulation. (C.O.)

**29411** STRAIN DIFFERENCES IN THE IMMUNE RESPONSE OF MICE. II. RESPONSES BY NEONATAL CELLS IN IRRADIATED ADULT HOSTS. Playfair, J. H. L. (Middlesex Hospital Medical School, London). Immunology, 15: 815-26(Dec. 1968).

Lethally x-irradiated NZB and C57Bl mice (850 rad) were injected with syngenic thymus and marrow, or thymus and liver cells, and immunized with sheep red blood cells (SRBC). As in intact neonatal mice, NZB plaque-forming cell (PFC) responses were significantly higher than C57Bl. X-irradiated (NZB × C57Bl) $F_1$ and (NZB × BALB/c)$F_1$ hybrid mice (900 rad) were given mixtures of parental and syngenic cells, but it was shown that the high NZB response to SRBC was characteristic of the newborn liver rather than of the thymus. NZB liver gave rise to more PFC against SRBC than BALB/c liver, but not more against chicken RBC. It is argued that liver cells contain genetic information regarding antibody specificity. C57Bl cells grew poorly in $F_1$ hosts, but the low SRBC response appeared to be characteristic of both liver and thymus. (BBB)

**29412** IN VITRO ANTIBODY SYNTHESIS BY DIFFUSION CHAMBER CULTURES OF SPLEEN CELLS. II. EFFECT OF INCREASED LEVELS OF FREE ANTIBODY. Vann, Douglas C. (Oak Ridge National Lab., Tenn.). J. Immunol., 102: 451-6 (Feb. 1969).

The effect of free antibody on antibody production in the secondary immune response was studied by use of antigen-stimulated primed spleen cells in diffusion chamber cultures. The cultures were exposed to high concentrations of antibody at various times after the cultures were begun, and antibody production was assayed by determining the amounts of in vitro radioactive amino acid incorporation into specific antibody. Chamber cultures implanted from the start in animals hyperimmunized to the test antigen (sheep red blood cells) failed to exhibit any significant antibody production. When the cultures were grown for 7 to 9 days in normal animals and exposed to free antibody either at the time of in vitro incubation or by transfer into hyperimmune animals for one or two days prior to the in vitro assessment of antibody production, there was no significant depression of antibody production. This was true even if the cultures were exposed to kiloroentgen doses of x ray at the beginning of the plateau phase of their immune response to eliminate turnover in the antibody-producing cell population. These results suggest that antibody-mediated regulation of antibody production occurs at the level of the antibody-producing cell population, possibly by preventing antigenic determinants from triggering progenitor cells that participate in the immune response, and not through control of the synthetic or secretory activities of antibody-producing cells. (auth)

**29413** ONTOGENY OF CIRCULATING IMMUNOGLOBULINS IN NORMAL, BURSECTOMIZED, AND IRRADIATED CHICKENS. Van Meter, Ronee; Good, R. A.; Cooper, M. D. (Univ. of Minnesota, Minneapolis. Univ. of Alabama, Birmingham). J. Immunol., 102: 370-4(Feb. 1969).

Normal chickens developed peak levels of IgM earlier than they developed peak levels of IgG. Despite its suppressive effect on primary antibody responses, bursectomy at hatching had no effect on the early rise in circulating IgM. This treatment delayed but did not prevent the normal increase with age of plasma IgG concentrations. Near-lethal whole-body x irradiation on the 2nd day of life did not suppress the development of circulating immunoglobulins. Early bursectomy and irradiation prevented synthesis of detectable IgM and IgG over an 8-week period in 59% of birds so treated. The observations suggest that circulating $\gamma$ globulin levels may bear no direct relationship to the number of stem cells of the plasma cell line. (auth)

**29414** IN VITRO ANTIBODY SYNTHESIS BY DIFFUSION CHAMBER CULTURES OF SPLEEN CELLS. I. METHODS AND EFFECT OF 10,000 r ON ANTIBODY SYNTHESIS. Vann, Douglas C.; Makinodan, T. (Oak Ridge National Lab., Tenn.). J. Immunol., 102: 442-50(Feb. 1969).

Techniques for the study of antibody production by primed antigen-stimulated spleen cells in cell-impermeable diffusion chambers were developed. The chambers were recovered from their host animals and incubated in vitro with radioactive amino

acids. Antibody production was measured by determining the amount of radioactivity which would specifically bind to erythrocyte stroma of the type used for immunization. The effect of kiloroentgen doses of x radiation on antibody production by plateau phase cultures was also studied in a system in which primed spleen cells in cell-impermeable diffusion chambers were irradiated 6 days after antigen stimulation. One and three days later the chamber cultures were incubated in vitro in the presence of $^{14}C$-labeled amino acids. The incorporation of radioactivity into total extracellular proteins, γG-globulin, and specific antibody was measured. Isotope incorporation in cultures which had received 10,000 R of x radiation was qualitatively and quantitatively similar to that by unirradiated controls, as judged by a variety of criteria. It was shown previously that irradiation of diffusion chamber cultures of antigen-stimulated spleen cells with kiloroentgen doses of x radiation in the plateau phase of their response leads to a purification of mature antibody-producing cells and virtually eliminates cell multiplication. It is shown here that the surviving immunocompetent cells are as efficient as unirradiated cells in synthesizing antibodies. Thus, it appears that heavily irradiated cultures of lymphoid cells should be useful for further biochemical studies of antibody synthesis and regulation. (auth)

**29415** SURVIVAL OF AND RESTORATION OF HEMOPOIESIS IN IRRADIATED MICE FOLLOWING HOMOTRANSPLANTATION OF FRESH AND CADAVERIC BONE MARROW FROM SEVERAL GENETICALLY DIFFERENT DONORS. Butomo, N. V. (Leningrad Military Medical Academy). Probl. Gematol. Pereliv. Krovi, 14: No. 5, 28-31(May 1969). (In Russian).

The effect of transplantation of homologous fresh and cadaveric bone marrow obtained from one or several genetically different donors on survival and restoration of hemopoiesis in irradiated mice, was studied. The survival of these animals proved to be greater than in transplantation of a mixture of bone marrow cells from several donors. Hematological examination demonstrated that in transplantation of bone marrow from many donors restoration of hemopoiesis may take place at the expense of proliferation of cells from several sources. (auth)

**29416** SYNTHESIS OF RNA BY NORMAL MOUSE SPLEEN CELLS AFTER STIMULATION WITH ANTIGEN IN VITRO. Ortiz-Ortiz, L.; Jaroslow, B. N. (Argonne National Lab., Ill.). Nature (London), 221: 1153-4(Mar. 22, 1969).

It is known that treatment of animals or tissue cultures with antimetabolites or irradiation during the first few hours after antigenic stimulation profoundly affects the immune response, and it was reported that "hot" pulses of tritiated thymidine were lethal to proliferating antibody-forming cells when added to dissociated spleen cell cultures stimulated with sheep erythrocytes in vitro if given 24 to 32 hr after antigen, but not when given earlier. This suggested that little or no DNA synthesis occurred before 32 hr in cells stimulated by antigen. In the study described the effects of "hot" pulses of tritiated uridine were investigated with a view to determining when antibody-forming cells and their precursors were actively synthesising RNA. It was found that active RNA synthesis occurred during the first 24 hr after antigenic stimulation as well as after 24 hr, when active DNA synthesis occurred. Details are given of the experimental technique adopted. (UK)

## Ecology

*Refer also to abstracts 29466, 29477, 29479, 29480, and 29484.*

**29417** (AEC-tr-7038) ROLE OF PLANTS IN CONTINENTAL RADIO-ECOLOGY. THE CASE OF THE GRENOBLE SITE. Ozenda, P. Translated from Bull. Inform. Sci. Tech. (Paris), No. 119, 3-8(1967). 17p. Dep. CFSTI.

Principles relating to the methods of radio-ecology as compared with those of general ecology are reviewed and an outline of research presently being carried out in this field by the Plant Biology laboratories of the Centre d'Etudes Nucleaires (Nuclear Studies Center) in collaboration with the Faculte des Sciences (Faculty of Science) of Grenoble is presented. (auth)

**29418** (AEC-tr-7039) DISTRIBUTION OF A MIXTURE OF FISSION PRODUCTS IN A MODEL SIMULATING A RIVER TYPE OF ECOLOGICAL ENVIRONMENT. Gagnaire, J.; Chamel, A.; Lachet, B.; Magnaval, R. Translated from Bull. Inform. Sci. Tech. (Paris), No. 119, 9-26(1967). 49p. Dep. CFSTI.

A mixture of salts of $^{85}Sr$, $^{137}Cs$, and $^{144}Ce$ in solution penetrates into a model consisting of fresh water and sediments only. The influence that the phenomena of retention on the sediments and the later salting-out have on the final state of equilibrium was determined. Then the localization of the radioelements and their power of concentration in filamentous algae or in reeds cultivated in the same model were studied. The presence of plants accelerates the disappearance of the radioelements in solution in the water in the first weeks after the pollution by radioelements, but it does not modify the final state of equilibrium between the liquid phase and the solid phase. (auth)

**29419** (AEC-tr-7040) STUDY IN INTERPRETATION OF THE VARIATION OF THE CONCENTRATION RATES OF RADIOELEMENTS IN BLACK POPLAR. Gagnaire, J.; Chamel, A.; Ferard, G.; Lachet, B. Translated from Bull. Inform. Sci. Tech. (Paris), No. 119, 27-37(1967). 27p. Dep. CFSTI.

The black poplar is characteristic of the plant associations of river banks. The extent to which the climatic, physiological, and chemical factors affect the localization and concentration of $^{45}Ca$, $^{85}Sr$, $^{106}Ru$, $^{137}Cs$, and $^{144}Ce$ in the poplar was studied. The variations in the rates of concentration of $^{40}K$ and $^{137}Cs$ in the leaves of poplars, willows, alders, and reeds were compared. The effects of uptake from the soil and direct absorption by leaves and other aerial plant parts are discussed. It was concluded that the stage in the vegetative cycle has a marked effect on the uptake of radioisotopes by the plant species studied. (C.H.)

**29420** (BMI-171-17) BIRD DIETARY. Bioenvironmental and Radiological-Safety Feasibility Studies, Atlantic–Pacific Interoceanic Canal. Duke, James A. (Battelle Memorial Inst., Columbus, Ohio). May 29, 1968. Contract AT(26-1)-171. 139p. Dep. CFSTI.

The ecology of birds in Panama, proposed site of interoceanic canal, is presented. Birds are listed by their scientific and colloquial names and a brief description of their local habitat and dietary habits is given. The role of these birds in man's food chain is discussed and their possible significance as radionuclide transmitters is mentioned. (E.R.B.)

**29421** (BMI-171-18) ARTHROPOD DIETARY. Bioenvironmental and Radiological-Safety Feasibility Studies, Atlantic–Pacific Interoceanic Canal. Duke, James A. (Battelle Memorial Inst., Columbus, Ohio). July 22, 1968. Contract AT(26-1)-171. 107p. Dep. CFSTI.

The ecology of the Phylum Arthropoda in Panama, proposed site of nuclear excavated interoceanic canal, is presented. The classes, subclasses, orders, and families of the phylum are listed by scientific and colloquial names and a brief description of their local habitat and dietary habits is given. The role of the Arthropods in man's food chain is described in relation to its significance as a radioisotope transmitter. (E.R.B.)

**29422** (BMI-171-19) BIOENVIRONMENTAL AND RADIOLOGICAL-SAFETY FEASIBILITY STUDIES, ATLANTIC–PACIFIC INTEROCEANIC CANAL. HERPETOLOGICAL DIETARY. Duke, James A. (Battelle Memorial Inst., Columbus, Ohio). Nov. 10, 1967. Contract AT(26-1)-171. 35p. Dep. CFSTI.

The dietary habits of amphibia and reptiles in Colombia and Panama in the vicinity of the interoceanic canal were investigated. The information is useful in determining the transport of radionuclides, produced by the underground nuclear explosion, through the food chain and ultimately to the human inhabitants of the area. The feeding habits of the following organisms are included: caecilians, salamanders, toads, frogs, lizards, geckos, iguanas, snakes, turtles, crocodiles, and alligators. (E.R.B.)

**29423** (BMI-171-21) MAMMAL DIETARY. Bioenvironmental and Radiological-Safety Feasibility Studies, Atlantic–Pacific Interoceanic Canal. Duke, James A. (Battelle Memorial Inst., Columbus, Ohio). Jan. 31, 1967. Contract AT(16-1)-171. 33p. Dep. CFSTI.

The ecology of the Class Mammalia in Panama, proposed site of a nuclear-excavated interoceanic canal, is presented. The mammals are listed by their scientific and colloquial names and a brief description of their local habitat and dietary habits is given. The role of these mammals in man's food chain as accumulators of radionuclides is discussed. (E.R.B.)

**29424** (SAN-310-P-4-6) PATHWAYS OF TRACE ELEMENTS IN ARCTIC LAKE ECOSYSTEMS. Progress Report, April 15, 1968–April 14, 1969. Barsdate, Robert J. (Alaska Univ., College. Inst. of Marine Science). Feb. 1969. Contract AT(04-3)-310PA4. 50p. Dep. CFSTI.

Three major areas of study related to the pathways of trace elements in Arctic lake ecosystems were studied. Consideration was given to the interaction of trace metals with dissolved organic material, the geochemical evaluation of the effects on the major cations of precipitation of dissolved organic complexes in distrophic lakes, and the distribution of trace metals between sedimentary materials and water. Methodology and results are discussed. A number of graphs and tables are presented. (C.O.)

**29425** (TID-24951) AN ECOLOGICAL STUDY OF SOUTH BISCAYNE BAY IN THE VICINITY OF TURKEY POINT. Progress Report, May 1, 1968-January 31, 1969. Bader, Richard G. (Miami Univ., Fla. Inst. of Marine Science). Contract AT(40-1)-3801. 63p. Dep. CFSTI.

A study was conducted to determine, in quantitative and qualitative terms, what the effects will be of incremental increases in thermal effluent from conventional and nuclear electrical generating plants being built at Turkey Point by Florida Power and Light Company. Two conventional generating units are now in operation and two nuclear units are scheduled for operation in 1970 and 1971. Some environmental degradation has already taken place adjacent to the effluent canals, but there are areas where no alteration in the biota or temperature has occurred. Thus, the research is being undertaken in Biscayne Bay and other unaffected control areas as well as on either side of the zone of change. (auth)

**29426** PSYCHOPATHOLOGICAL TROUBLES IN THE SURROUNDING OF NUCLEAR WORK. Sivadon, Paul; Fernandez, A. (Centre de Recherches Psychopathologiques, Paris). Ann. Med. Psychol. (Paris), 2: 201-13(July 1968). (In French).

A total of 536 persons of various backgrounds, employed in nuclear industries were examined. In no cases were psychological disturbances found that were great enough to require temporary or permanent relief from duty. Minor neurotic manifestations, psychosomatic problems, and a non-negligible fraction of pathological personalities and alcoholics with intellectual insufficiency were found. Several anomalies directly related to nuclear work included emotional syndromes tied to fear of radiation and accompanied by interpretative tendencies, and psychosomatic syndromes related to old or recent situations of radioactive risk. The mechanism of isolation of work from personal life and displacement of latent anxiety were noted. The fraction of anomalies is not greater in nuclear workers than in the metallurgical industry, according to the study of Russel Fraser. The major characteristic of anomalies is reduction of adaptability. (BBB)

**29427** HOW LIFE RESUMES ON IRRADIATED LAND. Barloy, Jean-Jacques. Sci. Avenir, No. 261, 906-11; 927(Nov. 1968). (In French).

The return of the natives of Bikini to their island home prompted a review of the relative responses of different forms of life to radiation and the return of various living organisms to areas where life has been destroyed by radiation; a review of the progress of radioecology is given. In general, life is destroyed by intense heat near a nuclear explosion, or may be destroyed by shock waves. More generally the problem of contamination by fallout, specifically by fixation of $^{90}Sr$, $^{131}I$, and $^{137}Cs$ by living organisms, contributes greatly to mortality. Other studies in the Pacific with $^{60}Co$, $^{55}Fe$, and $^{65}Zn$ are noted. Studies at Brookhaven with two biotopes (a forest, and a field) are reviewed to illustrate varying responses of vegetable life to buried sources of radiation. The mechanism of recolonization depends on the species as well: chromosomal makeup is obviously important, but for some animals habitation may preserve the species. The special problem of man is touched upon. (BBB)

**29428** SOLAR ULTRAVIOLET RADIATION AS AN ECOLOGICAL FACTOR FOR ALPINE PLANTS. Caldwell, Martyn M. (Utah State Univ., Logan). Ecol. Monogr., 38: 243-68(Summer 1968).

Ultraviolet radiation was examined as an environmental factor of alpine plants growing on the east slope of the Colorado Front Range. Solar uv intensities, the effects of uv exclusion on plant growth and development, and adaptive mechanisms of alpine plants to solar uv were considered. There were some indications of a promotion of plant growth and development caused by the exclusion of solar uv, e.g., flowering of Trifolium dasyphyllum was enhanced significantly at the 5% level. Using high intensity monochromatic irradiation in the laboratory, an inverse relation was found between uv filtration capacity based on epidermal uv transmission and sensitivity to uv-B spectrum damage. Photoreactivation (PR) of damage produced by uv-B wavelengths specifically within the terrestrial solar spectrum was demonstrated for several alpine plants. The importance of PR in nature was implied by subjecting the alpine plants to a simulated alpine day of precisely defined uv-B irradiation without the presence of longer wavelengths. The destruction caused by uv-B was evident in a few individuals. In nature, where high intensity visible and uv-A radiation is available for PR, such severe tissue destruction does not usually occur. (BBB)

**29429** APPLICATION OF INFORMATION THEORY TO THE STUDY OF THE STIMULATING EFFECTS OF IONIZING RADIATION, THERMAL ENERGY, AND OTHER ENVIRONMENTAL FACTORS: PRELIMINARY IDEAS FOR A THEORY OF ORGANIZATION. Atlan, Henri (Ames Research Center, Moffett Field, Calif.). J. Theor. Biol., 21: 45-70(Oct. 1968).

The stimulating effects of low doses of ionizing radiation or of factors of the normal environment that are detrimental at higher levels are considered along with the stimulating effects of thermal energy and of the passage of time. These effects exemplify a basic property of living matter, i.e., the ability to increase information content up to a certain limit under the influence of contingent external factors. In the transmission of information between substructures, the noise resulting from external contingent factors may act as a factor of autonomy which increases the complexity and efficiency of living systems. This concept was applied to extend Yockey's equations to the domain of low doses of environmental factors. A change in alphabet appears necessary to ensure that living systems with increased autonomy can overcompensate the information destruction caused by low doses of contingent factors. (BBB)

**29430** FILTERING AND PROTECTIVE EFFECT OF FORESTS AGAINST RADIOACTIVE AND OTHER IMPURITIES OF THE ATMOSPHERE. Herbst, W. (Univ., Freiburg i. B.). Forst-Holzwirt, 20: 216-20(1965). (In German).

Forest trees influence the content and deposition of radioactive material in the atmosphere. Although they cannot be considered a perfect protection, they still have a considerable beneficial effect through their filter action. The future of mankind requires more intensive studies of the problems involved. (H.G.B.)

**29431** RESERVOIR FISHERY RESOURCES SYMPOSIUM, THE UNIVERSITY OF GEORGIA CENTER FOR CONTINUING EDUCATION, ATHENS, [APRIL 5-7, 1967]. Athens, Ga., University of Georgia, 1967. 576p. (CONF-670456). American Fisheries Society, Washington, D. C. $10.00.

Thirty-eight papers discuss various aspects of reservoir management with emphasis on the management of fishery resources in the Southeastern United States. A separate abstract was prepared for one paper. (C.H.)

*For an abstract of the individual paper see: 29432.*

**29432** ECOLOGICAL BEHAVIOR OF RADIONUCLIDES IN THE CLINCH AND TENNESSEE RIVERS. Nelson, D. J. (Oak Ridge National Lab., Tenn.). pp 169-87 of Reservoir Fishery Resources Symposium. Athens, Ga., University of Georgia, 1967.

See CONF-670456.

Biological investigations in connection with the Clinch River Study sought to determine the uptake and turnover of radionuclides in biota, the effect of biota in redistributing radioactivity, and the effect of ionizing radiation on aquatic organisms. Conventional fish tagging studies were conducted with the Clinch River fish, and, in addition, movements of smallmouth buffalo were studied by use of radionuclides deposited in their scales. Scale radioactivity, detected by autoradiography, provided a continuum of information with respect to the movement of fish into and out of areas contaminated with radionuclides. The white crappie was selected for intensive study because the tagging survey showed that it did not migrate far in the river, and therefore its exposure to radioactive waste releases could be estimated more closely. A good agreement was observed between the specific activity of $^{90}Sr$ in water and fish tissue which showed that $^{90}Sr$ concentrations in fish may be predicted for constant releases of $^{90}Sr$ to the river. Freshwater clams were also good indicators for $^{90}Sr$ in river water. Clams are relatively immobile on the river bottom, and the concentration of $^{90}Sr$ in their shells was directly proportional to the concentration of $^{90}Sr$ in river water to which they were exposed. The effects of radiation on aquatic organisms were studied by examination of the salivary gland chromosomes of Chironomus tentans larvae in an effort to detect chromosomal aberrations which might be attributed to radiation exposures. Induced aberrations were observed, but these were eliminated from the population by natural selection. Hence, no permanent radiation damage to the population has occurred. Estimates of radionuclides incorporated in the biomass of fish, clams, and insects living in the river suggest that activities of aquatic organisms are not important as vectors of radioactivity nor will organisms contain a significant quantity of radioactivity. These results suggest that the greatest hazard to man from a contaminated environment will result from the consumption of contaminated food and water. (auth)

## Genetics and Cytogenetics

*Refer also to abstracts 29308, 29732, 29742, 29770, 29791, 29894, and 29895.*

**29433** (COO-332-6) TECHNICAL PROGRESS REPORT [ON CHLOROPLAST PIGMENTS IN BARLEY MUTANT]. [Snyder, L. A.] (Minnesota Univ., Minneapolis). Jan. 6, 1969. Contract AT(11-1)-332. 17p. Dep. CFSTI.

The ultrastructure of chloroplasts from normal barley, x-radio-induced mutants, and mutants induced by ethyl methanesulfonate was studied. Emphasis was placed on the identification and quantitation of chloroplast pigments in chlorophyll-deficient mutants. The synthesis of carotenoid pigments and proteins in barley mutants was also studied. (C.H.)

**29434** (COO-1512-12) APPLICATION OF BIOMETRICAL GENETIC TECHNIQUES TO IRRADIATED AND NONIRRADIATED POPULATIONS OF CORN TO PROVIDE INFORMATION ON NATURE OF GENE ACTION INVOLVED IN THE INHERITANCE OF QUANTITATIVE TRAITS AND IN HETEROSIS. Technical Progress Report, 1968-69. Gardner, C. O. (Nebraska Univ., Lincoln. Dept. of Agronomy). Feb. 26, 1969. Contract AT(11-1)-1512. 20p. Dep. CFSTI.

Quantitative radiation genetics investigations on corn grown in the field are discussed and summarized. Studies on a largely self-pollinating species, sorghum, were initiated also. Comparison was made of the chemical mutagen ethyl methane sulfonate (EMS) with thermal neutron or x ray irradiation in their effects on genetic quantitative traits using biometric methods. A summary of the research papers resulting from this work is presented; each experiment not previously reported is presented and briefly discussed. (C.O.)

**29435** (UCR-34-P-105-12) DIFFERENTIAL RADIOSENSITIVITY IN GERM CELLS OF DROSOPHILA. Progress Report for the Period 1966-1969. Parker, Dean R. (California Univ., Riverside). 35p. Dep. CFSTI.

Nuclear geometry was studied in relation to production and recovery of chromosome aberrations. These studies included production and analysis of Y chromosome fragments and investigations on site number and sensitivity in Drosophila oocytes, as determined by Wolff's equations for describing the kinetics of observation induction. Studies were conducted on problems of assaying radiation damage induced in cells undergoing meiosis. Radiation was used to produce detachments for experiments on disjunction following interchange. The mechanism of radioinduced nondisjunction of homologous chromosomes was investigated. Disjunctional properties of asymmetrical dyads were examined, and distributive pairing relationships in oocytes were analyzed. Experiments were conducted on the pairing properties of chromosomes; the finding of nonrandomness in the segregational properties of a radioinduced recombinant fourth chromosome suggested that this might be a useful way of characterizing the induced crossovers. The phenomena of position effects involving breaks in heterochromatic regions only were studied. Temperature shift experiments and brooding experiments are in progress to determine the timing of the temperature sensitive period. Cytogenetic analyses of the Y chromosome were undertaken by inducing a new set of Y mutants using chemical mutagens; results are significant in determining the nature of heterochromatin, the nature of genes located in heterochromatin, and the nature of genetic control of spermiogenesis. New stocks are being produced by chemical mutagens and by x radiation. (H.L.W.)

**29436** NON-PHOTOREACTIVABLE MUTANT OF SERRATIA MARCESCENS. Winkler, U.; Heil, K. (Univ., Frankfurt am Main). Photochem. Photobiol., 9: 99-102(Jan. 1969).

A non-photoreactivable mutant of Serratia marcescens is described. Kappa bacteriophages, inactivated by uv radiation during and shortly after sorption on resting cells of the Serratia mutants, were reactivated during exposure to light. (C.H.)

**29437** GENETIC AND CYTOLOGICAL STUDIES OF TRADESCANTIA IRRADIATED DURING ORBITAL FLIGHT. Sparrow, A. H.; Schairer, L. A.; Marimuthu, K. M. (Brookhaven National Lab., Upton, N. Y.). Idengaku Zasshi, 43: 470-1(1968).

The effects of weightlessness and other spacecraft environmental conditions on spontaneous and radioinduced mutation rates and on cytological changes were studied in Tradescantia. During the Biosatellite flight, the flower buds were exposed to 218 R of $\gamma$ rays, and the roots received 125 to 285 R. The results showed no effects of spaceflight factors on spontaneous levels of somatic mutation, but enhanced interactions between radiation and spaceflight factors were indicated by an increase in pollen abortion, stamen hair stunting, and chromosome aberrations. (F.M.M.)

**29438** MUTATION MECHANISMS. SYNOPTIC REPORT. Winkler, Ulrich (Univ., Frankfurt am Main). Ber. Deut. Bot. Ges., 80: 470-8(Dec. 30, 1967). (In German).

Some effects of uv irradiation in producing mutations are discussed. In bacteria, fungi, and corn pollen where uv-radioinduced premutations known as photoreversions occur the enzyme reactions can be controlled since they respond only to illumination with uv light of 254 nm wavelength. Differences between premutations are discussed, and examples of the transitions, transversions, insertions, and deletions that may result are described briefly. The multiple steps involved in a point mutation induced by uv light, and endosperm mutations induced in corn pollen by uv irradiation are illustrated. The inactivation of reproduction capacity and elicitation of clear plaque mutations of Kappa phage at a dose rate of 27 KR/min of 55 kV x irradiation as a function of genotype in Serratia marcescens are shown. (BBB)

**29439** RADIATION-INDUCED BREAKS OF DNA IN CULTURED MAMMALIAN CELLS. Veatch, W.; Okada, S. (Univ. of Rochester, N. Y.). Biophys. J., 9: 330-46(Mar. 1969).

Mouse leukemic cells (L5178Y) in suspension culture were x irradiated (1-MeV, 76,000 rad/min for up to 10 min) and the extent of single-strand breaks and double-strand cuts of DNA was estimated by sucrose gradient centrifugation. The number of single-strand breaks in cultured mammalian cells was found to be ~3 breaks/cell/rad while the number of double-strand cuts was ~0.3 cuts/cell/rad. When the number of breaks or cuts was expressed in terms of the $D_0$ dose, the value was equivalent to the average number of breaks or cuts occurring for one cell to be killed. Since the $D_0$ dose of L5178Y cells in suspension culture was 180 rad, 540 single-strand breaks and 60 double-strand cuts would be produced per $D_0$ dose. In suicide experiments the number of tritium atoms in DNA which had to decay in order to kill one L5178Y cell was estimated to be about 170 in the unifilar labeled cells and 80 in the bifilar labeled cells. The number of chromosome bridges induced by irradiation in L5178Y cells was estimated to be $5 \times 10^{-5}$ bridges per cell (rad), corresponding to 1.6 bridges per cell at $D_0$ = 180 rad. Therefore most of the breaks and cuts as well as damage to DNA by tritium decay would not result in killing or in chromosomal damage. To account for cell killing from so much damage to DNA molecules, it would be necessary to introduce several assumptions, none of which has been evaluated. (BBB)

**29440** DEVELOPMENT OF CHROMOSOME REARRANGEMENTS IN THE CORNEAL EPITHELIUM OF MICE EXPOSED TO A PROLONGED WHOLE-BODY GAMMA-IRRADIATION. Zukhbaya, T. M.; Markelov, B. A.; Popova, N. A. Kosm. Biol. Med., 3: No. 2, 71-2(Mar.-Apr. 1969). (In Russian).

The influence of single whole-body irradiation on the process of chromosome reconstruction was studied using 350 young white mice. Mice weighing 16 to 20 g were irradiated by various doses (from 12.5 to 400 R) of $^{60}Co$ $\gamma$ rays. Tabulated data show that a decreased dose but increased duration of exposure (up to 20 hr) reduced the formation of chromosome rearrangement in the corneal epithelium, but the general injury to the mice depends on the radiation dose. (R.V.J.)

**29441** ON THE JOINT ACTION OF THE RADIOPROTECTOR AET AND $\gamma$-IRRADIATION IN THE PRODUCTION OF CHLOROPHYLL MUTATIONS IN BARLEY. Panoyan, R. E. (Inst. of General Genetics, Moscow). Radiobiologiya, 9: 328-9(1969). (In Russian).

The joint action of the radioprotector AET and $\gamma$-irradiation on the genetic variability of barley in $M_2$ and $M_3$ was studied. Chlorophyll mutations were selected as the basic genetic index. It was established that at a comparatively low dose of irradiation (20 kR), the radioprotector lowers the percentage and spectrum of chlorophyll mutations, while at a higher dose (30 kR) it increases it. This is explained by an increase in the survival rate of the modified forms of the plants when the radioprotector AET is used. (auth)

**29442** INFLUENCE OF PUROMYCIN AND 5-FLUORO-2'-DEOXYURIDINE ON PROCESSES OF FORMATION OF CHROMOSOME REARRANGEMENTS IN IRRADIATED SEEDS. Mitrofanov, Yu. A.; Kotomina, I. F. (Inst. of General Genetics, Moscow). Radiobiologiya, 9: 271-6(1969). (In Russian).

The influence of puromycin and 5-fluoro-2'-deoxyuridine on irradiated and normal cells of Crepis capillaris was studied. Puromycin does not induce the formation of chromosome rearrangements in the $G_1$- and S-phases of the mitotic cycle. Treatment of irradiated cells with it at these same periods leads to an increase in the number of rearrangements, chiefly on account of dicentrics and rings. The maximum effect from treatment with 5-fluorodeoxyuridine was observed in the case of influence on the cells in the S-phase; an increase in the number of aberrations without connections of fragments, a decrease in the number of dicentrics and rings, and an increase in the number of slits were detected. Modification of the radiation effect with puromycin occurred without any change in the spectrum of aberrations, while

that with 5-fluorodeoxyuridine occurred with a change in the spectrum. (auth)

**29443** INFLUENCE OF IRRADIATION OF FLAX FIBER SEEDS AND PLANTS ON THE APPEARANCE OF MUTATIONS WITH ECONOMICALLY VALUABLE CHARACTERISTICS AND PROPERTIES. Sharov, I. Ya. (All-Union Scientific Research Inst. of Horticulture, Moscow). Radiobiologiya, 9: 277-80(1969). (In Russian).

The irradiation of flax fiber plants and seeds stimulated the appearance of mutations with economically valuable characteristics and properties. Seeds with high resistance to lodging and fusariosis were isolated. Mutants were obtained surpassing the original variety in yield of seeds by 6 to 45%, and fiber content by 11 to 54%. Five of the mutants were turned over to selective breeders for use in selective breeding work. Mutants with a good yield and quality of fiber were obtained after irradiation of seeds and plants at doses of 0.500 to 20 kR and 80 to 120 kR. Mutations resistant to lodging and diseases were obtained at doses of irradiation of 150 to 120 kR. (auth)

**29444** EFFECT OF TEMPORAL DISTRIBUTION OF DOSES ON RADIATION-INDUCED INHIBITION OF MITOSIS IN EHRLICH-ASCITES-TUMOR CELLS. Kaufmann, Horst; Bartholomae, Hans-Joachim (Roentgen Inst., Essen). Strahlentherapie, 136: 729-32(Dec. 1968). (In German).

The duration of the mitotic delay caused by radiation was studied in Ehrlich ascites tumor cells, at different dose levels and dose rates. A clear time factor effect was observed when this was inferior to one. Longer protraction increased the mitotic delay time. An explanation for this is that radiation causes an increase of the sensitivity of the cellular population due to an accumulation of cells in a sensitive phase. This accumulation is caused by a reversible blocking of leaving the sensitive phase, whereas entering the same phase is not influenced. (auth)

**29445** PROTECTIVE EFFECTIVENESS OF CYSTEINE, CYSTEAMINE, AND CYSTAMINE AGAINST X-INDUCED CHROMOSOME ABERRATIONS AT DIFFERENT STAGES OF MITOSIS. Mikaelsen, K.; Pedersen, K. (Univ. of Bergen). Hereditas, 60: 399-406(1968).

The protective effectiveness of cysteine, cysteamine, and cystamine on chromosome aberrations was studied in root meristems of Allium cepa exposed to 100 R of x irradiation. After 60 hr of germination at 22°C in darkness the seeds were treated with 0.001M solutions of the chemicals for 1 hr prior to an exposure. The effects of these sulfhydryl agents on chromosome aberrations were analyzed on the basis of acentric fragments and dicentric bridges in cells at first anaphase. When compared with seeds irradiated in water, cysteine, cysteamine, and cystamine showed a protective effect on radiation-induced chromosome breakage. For cysteine-treated seeds, a reduced fragment frequency was found at all fixation times between 4 to 24 hr but for cysteamine and cystamine significant reductions in fragment frequency were only shown at 18 and 24 hr fixation time. At 2 hr after irradiation no significant effect could be demonstrated although cysteamine gave a lower yield of chromosome aberrations. The frequencies of damaged or abnormal anaphases followed also the same trend as for chromosome aberrations. Thus significant effects were demonstrated only in cells which were in interphase at the time of irradiation. Cysteine was effective at all stages of interphase but cysteamine and cystamine were only effective in early interphase, the $G_1$ stage. (BBB)

**29446** CHANGES IN THE OIL CONTENT OF IRRADIATED LINES OF PEANUTS. Martin, Jean-Pierre (Centre de Recherches Agronomiques, Bambey, Senegal). Oleagineux, 23: 105-8 (Feb. 1968). (In French).

Studies were made on mutations of peanuts induced by irradiation of seeds during four generations. Six lines of descendants of the early variety were tested for their oil richness and early maturity. These six lines were very similar to each other in their oil richness and they were more homogeneous than the parent for their total variability. All had greater oil content than the parent. A description is given of the six lines. (J.S.R.)

**29447** EFFECT OF WATER CONTENT ON THE RADIATION-INDUCED CHROMOSOME DAMAGE IN DORMANT SEEDS OF CREPIS CAPILLARIS. Nemtseva, L. S.; Romanov, V. P. (Inst. of General Genetics, Moscow). Genetika, 5: No. 5, 55-68(May 1969). (In Russian).

The effect of different types of ionizing radiation on the dormant seeds of Crepis capillaris at different values of water content was studied. The effects of water content in the seeds on the radiation-induced chromosome damages are different in case of sparsely and densely ionizing radiations. The curve of the response of chromosome damages to the water content in the seeds following x- and γ-irradiation is characterized by the ascent and the subsequent decline with a peak at 3% water content. The curve of the response of chromosome damages to the water content in the seeds following the exposure to fast neutrons is rectilinear. Chromosomes in superdry (≤1% water) cells are extremely resistant to ionizing radiations. (auth)

**29448** COMPARATIVE STUDY OF THE CHROMOSOME ABERRATIONS AND FREE RADICALS IN IRRADIATED PEA SEEDS. Lebedeva, L. I.; Ermolaev, V. K. (Inst. of Cytology and Genetics, Novosibirsk, USSR. Inst. of Kinetics and Combustion, Novosibirsk, USSR). Genetika, 5: No. 5, 69-80(May 1969). (In Russian).

Differences were established in the frequency and types of chromosome aberrations in the cells of seed embryos of the pea variety Capital, spontaneous, radiation-induced and accumulating during the post-irradiation storage. The proportion and distribution of aberrant cells depend also on the temperature during the irradiation. (The effects of irradiation at 22° and −196°C were compared). A quantitative comparison between free radicals and injuries of chromosome structures was carried out. For this purpose the accumulation, recombination and ESR spectra of the free radicals in seeds irradiated at 22° and −196°C were studied. The yields of radicals at both irradiation temperatures proved to be the same (~4.0 · 1/100 ev), but as is shown by the analysis of the spectra and of the recombination data, the nature of the radicals does depend on the irradiation temperature. According to the recombination rate at 22°C the radicals are conventionally classified into two types: short-lived and long-lived. Most injuries (about 90 per cent) can be explained on the basis of the free radical hypothesis. In this case the observed linear correlations can be regarded as indicative of the possibility of a chromosome break as the result of the reaction with a single free radical. (auth)

**29449** MUTAGENIC EFFECT OF DIFFERENT TYPES OF IRRADIATION ON THE GERM CELLS OF MALE MICE. I. THE COMPARATIVE GENETIC RADIOSENSITIVITY OF SPERMATOGONIA AND OF THE OTHER STAGES OF SPERMATOGENESIS. Pomerantseva, M. D.; Ramaiya, L. K. (Inst. of General Genetics, Moscow). Genetika, 5: No. 5, 103-12(May 1969). (In Russian).

Comparative genetic radiosensitivity of the germ cells of male mice was studied at different stages of spermatogenesis. It is shown that the frequency of induced dominant lethal mutations in spermatogonia is considerably (by 10−15 times) lower than at later stages of spermatogenesis. In the spermatozoa, spermatids, and spermatocytes the frequency of mutations regularly increases with the increasing dose, while the dose-effect curve in the spermatogonia is distinctly different. Thus, the yield of dominant lethals in the spermatogonia remains at the same level with the increase of the dose from 400 to 1200 R. The mean induced embryonal postimplantation mortality is about 4%. A similar dose-effect curve is observed for the frequency of induced reciprocal translocation in spermatogonia, as it was shown by means of the cytological studies at the stage of diakinesis-metaphase of the 1st meiotic division. The preliminary data on the genetic effectiveness of the treatment with fast and intermediate neutrons suggest that the genetic effectiveness of fast and intermediate neutrons is about 4 and 6 times respectively as high as that of x-rays. (auth)

**29450** STUDIES ON THE BEHAVIOR OF RADIATION-INDUCED CHROMOSOME ABERRATIONS IN THE MODEL POPULATIONS OF DROSOPHILA MELANOGASTER. Mglinets, V. A. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, 5: No. 5, 113-18(May 1969). (In Russian).

The density of chromosome rearrangements induced by γ-irradiation (5000 R) was studied. In numerically stabilized model populations specified by a high pressure of natural selection a rapid elimination of chromosome rearrangements was observed. In numerically growing populations, subjected to a relatively low selection pressure during the first generations, some inversions can persist until the selection pressure attains its maximum level, and then a rapid elimination of inversions similar to that in the former case takes place. In growing populations and in those influenced by the effect of heterosis certain inversions can persist for a number of generations even after the selection pressure has attained its maximum value. (auth)

**29451** UV-INDUCED MUTAGENESIS IN $REC^-$-STRAINS OF ESCHERICHIA COLI K-12. Likhoded, L. Ya.; Kiryushkina, A. A.; Skavronskaya, A. G. (Gamaleya Inst. of Epidemiology and Microbiology, Moscow). Genetika, 5: No. 5, 137-40(May 1969). (In Russian).

The frequency of spontaneous and uv-induced reversions in the threonine locus of $rec^+$- and $rec^-$-strains was studied. It is shown that the frequency of spontaneous mutations is approximately similar in all the strains. The mutations in the $rec^-$-mutants were induced at lower uv-doses than in $rec^+$ bacteria.

However the maximum mutation frequency in the rec⁻ cells was less than that in the rec⁺ bacteria. It is assumed that the reactions controlled by the rec gene are required for the completion of the mutational process and for the formation of mutants. It is also established that the number of the viable rec⁻ cells grown after uv-irradiation on nutritional media of full value depends on the time of incubation and attains its maximum by the 5th day of incubation. It is assumed that the rec⁻ cells repair the uv-induced damages more slowly than the rec⁺ cells. (auth)

**29452** STUDIES OF THE GENETIC MECHANISM OF RADIATION-INDUCED MITOTIC SEGREGATION IN YEAST. Nakai, S.; Mortimer, R. K. (Univ. of California, Berkeley). Mol. Gen. Genet., 103: 329-38(Mar. 18, 1969).

Sectoring was induced with x rays or ultraviolet in a diploid yeast strain heterozygous for seven genes located on one chromosome arm. The frequencies of sectoring of different genes were approximately linearly related to their distance from the centromere. If two or more adjacent genes sectored, the event could be explained by mitotic crossing over. Sectoring of single genes, however, was mostly nonreciprocal and resembled a conversion-type event. Approximately 80% of the sectored colonies could be explained by single mitotic crossovers in one of the intergenic regions. (auth)

**29453** DIFFERENT RADIATION SENSITIVITY THROUGHOUT THE CELL CYCLE AGAINST FAST ELECTRONS OF DIFFERENT ENERGY SPECTRA. Markus, B.; Vogt, W. (Univ., Goettingen, Ger.). Biophysik, 5: 357-69(1969). (In German).

Chromosome aberrations in seedlings of Allium cepa have been scored at different times after irradiation. Equal doses (136 R) of 14.2 MeV electrons were given at 5 and 53 mm depth within a Plexiglas phantom. The frequency of aberrations showed one maximum for 5 mm and two maxima for 53 mm irradiation which could have been correlated to G2 and S cells, respectively, and G2 cells using H3-Thymidine. (auth)

**29454** THE RESPONSE OF A RADIATION-INDUCED DWARF BEAN MUTANT TO GIBBERELLIC ACID. Moh, C. C.; Alan, J. J. (Inst. of Agricultural Sciences, Turrialba, Costa Rica). Contract AT(30-1)-2043. Turrialba, 17: 176-8(Apr.-June 1967).

A dwarf bean mutant induced by $\gamma$ radiation was used to test the growth response to gibberellic acid (GA). This dwarf mutant was controlled by a single recessive gene and was characterized by having very short internodes and smaller leaves with darker green color compared with the normal counterparts. Weekly applications of aqueous GA solution from 1 to 32 ppM were capable of converting the dwarf mutant into a normal phenotype. It appears that this dwarf is a GA-deficient mutant. It is postulated that the action of this dwarf gene is to block completely or partially the biosynthetic pathway for the production of a GA-like substance necessary for the normal growth. (auth)

**29455** INFLUENCE OF THE AGE OF THE CULTURE ON RADIOINDUCED CHROMOSOME ABERRATIONS OF HUMAN LYMPHOCYTES OF THE PERIPHERAL BLOOD. Golob, Erich; Fischer, Patricia; Kunze-Muehl, Elfriede (Univ., Vienna). Strahlentherapie, 137: 63-7(Jan. 1969). (In German).

Human venous blood was irradiated with doses of 50, 100, and 200 r. For each experiment, the blood samples were divided into three aliquots for a lymphocyte culture. The first was harvested after 48 hrs and the next after 72 and 96 hrs. The number of the chromosomes was counted from 3658 metaphases and also number and type of chromosome aberration and of polyploid nuclei. It has been found that, for these experiments under standard circumstances, the number of abnormal nuclei decreases as does the frequency of aberrations after a dose of 200 r, with the time of culture. After a lower dose (50 and 100 r) this phenomenon does not have the same statistical certainty. The number of polyploidic nuclei increases in a significant way with the culture time for all applied doses. (auth)

**29456** EXTERNAL FACTORS AND THE GENOME. Saksela, Eero. Duodecim, 84: 377-89(1968). (In Finnish).

A review of the effects of uv radiation and x rays on genetics is presented. (auth)

**29457** GENETIC EFFECTS OF RADIATION ON MAMMALIAN POPULATIONS. Green, Earl L. (Jackson Lab., Bar Harbor, Me.). Annu. Rev. Genet., 2: 87-120(1968).

This review (with 83 references) deals with experimental attempts to detect and measure the effects of germ-cell irradiation on the fitness and other qualities of later generations in mammalian populations. Ten experiments with male or female germ cells of mice, rats, or swine exposed to radiation in one generation, five populations with male and female germ cells of rats or mice continuously exposed to radiation for several successive generations, and seven populations with male or female or both male and female germ cells of mice or rats exposed to radiation once in each of several successive generations have provided evidence bearing on the question of deleterious heterozygous effects of mutations. The classical findings that irradiation of sperm induces genic or chromosomal changes leading to death, sterility, and semisterility were amply confirmed and extended to include similar results in low, but measurable, frequencies from the irradiation of spermatogonia. Estimates of the rates of induction of recessive visible, recessive lethal, and semidominant lethal mutations per gamete per roentgen show disagreements that require more experiments. Per-gamete rates will be necessary for reliable predictions of the genetic consequences of exposing nonexperimental populations to radiation. Attempts to measure the effects of presumptive new mutations on the fitness and other traits of heterozygotes, either after one generation of parental exposure or after several generations in which the mutations may accumulate have, in general, been unsuccessful. The apparent inability of radiation to cause a detectable increase in the frequency of near-recessive semidominant mutation does not mean that random-breeding populations can be freely exposed to radiation without concern about the genetic consequences. (BBB)

**29458** THE ISOLATION OF AN OXIDASE-NEGATIVE STRAIN OF PSEUDOMONAS AERUGINOSA FROM THE URINE OF A COBALT-IRRADIATED PATIENT. Holmgren, J. (Univ. of Goeteborg, Sweden). Acta Pathol. Microbiol. Scand., 73: 583-91(1968).

Observations on an oxidase-negative strain of P. aeruginosa, isolated from the urine of a $^{60}$Co $\gamma$-irradiated patient, are reported. Whether $^{60}$Co $\gamma$ irradiation treatment may have induced the lack of oxidase in the bacteria is considered. The patient, a male, 67 yr old, suffered from hematuria, his urine initially containing oxidase-positive P. aeruginosa. A left-side hypernephroma was diagnosed and removed, and after the operation the patient was treated with $^{60}$Co $\gamma$ irradiation. This treatment consisted of five irradiations (400 R each, directed towards the operation site at a distance of 60 cm) with intervals of 2 days between the irradiations. The treatment was completed on the day a urine sample containing an oxidase-negative strain (Py ST) was collected. More than 2000 strains of P. aeruginosa, isolated from samples sent to the lab, when tested for the presence of oxidase with Kovac's method gave a positive oxidase reaction. Only the one strain isolated from the irradiated patient was oxidase negative. The probability that a radioinduced mutation accounted for the oxidase-negative strain is suggested. (BBB)

## Health Physics and Safety

*Refer also to abstracts 29014–29016, 29251, 29314, 29426, 29545, and 29854.*

**29459** (AERE-PR/HPM-13) HEALTH PHYSICS AND MEDICAL DIVISION PROGRESS REPORT, JANUARY–DECEMBER 1968. Johnston, J. E. (ed.) (Atomic Energy Research Establishment, Harwell (England)). Mar. 1969. 49p. Dep. CFSTI. UK 8s. 0d.

Studies are reported under the following headings:

AEROSOLS. Physical chemistry; natural environment; physics; atmospheric pollution.

RADIATION PHYSICS. Neutron dosimetry and radiobiophysics; personnel dosimetry; special investigations; radiation spectrometry and computer processing; fallout.

METABOLIC STUDIES. Measurement of Pu in lung; retention of alkaline earths; actinides; Cs and K; retention in thorax; neutron activation analysis in vivo; instrumentation; trabecular bone.

OPERATIONS GROUP. Human biology and biomedical research (inhalation studies; asbestos studies; tritium studies); bioassay.

MEDICAL SERVICES. Study of ischaemic heart disease; smoking clinic; tetanus immunization; clinical pathology; radiology.

A list of publications by the staff is included. (UK)

**29460** (RT/PROT-(68)17) HAEMATOLOGICAL EXAMINATIONS IN THE EVALUATION OF THE FITNESS TO THE WORK WITH RISK OF IONIZING RADIATION: SECOND OBSERVATION ON 9436 HAEMOGRRAMS. Strambi, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 14p. (In Italian). (CONF-681047-1). Dep.

From 31th Conference of the Italian Industrial Medical Society, Bologna, Italy.

With reference to a previous note, the main results obtained by 9,436 hematological examinations on peripheral blood are reported. The examinations were carried out on a semestrial basis, during the period 1962 to 1966 and are referred to a fraction of the population examined previously, i.e., 1,144 workers (1,018 men

and 126 women) aging between 25 and 40 years. The comparison of the results allows us to suggest a dynamic criterion, which takes into account the time dependence of individual variability, for evaluating the range of statistical normality. Such a criterion could be used as a reference source for assessing the fitness to radiation work. (auth)

## *Radioactive Contamination and Decontamination*

*Refer also to abstracts 28688, 29310, 29317, 29338, 29432, 29708, 29826, and 29862.*

**29461** (AEC-tr-7022) RADIATION DOSES DUE TO MARINE RADIOACTIVE CONTAMINATION. Translated from Genshiryoku Kogyo, 14: No. 10, 10-32(1968). 61p. Dep. CFSTI.

Problems presented by the contamination of ocean waters by radioactive effluents from nuclear reactors are discussed. Information from the world literature is summarized. Topics presented include: radioisotope movement in ocean; radioisotope content of marine organisms at various locations; radiation dose to man from ingestion of contaminated sea foods; hazards of external irradiation of man by contact with radioactive contaminants in the seas; and measures for the reduction of marine radioactivity. (75 references.) (C.H.)

**29462** (AED-C-13-6) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 13. DECONTAMINATION. Philipp, Hermann; Wichmann, Erich (comps.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Oct. 1968. 45p. (In Several Languages). Dep.

Over two hundred and fifty references are presented under the following headings: decontamination of buildings and equipment, decontamination of material, decontamination of persons and animals, decontamination of liquids, decontamination of gases, general, and review articles and bibliographies. Author, report number, and patent number indexes are included. The period covered is 1966 and 1967. (M.C.G.)

**29463** (BNWL-778-12) ENVIRONMENTAL SURVEILLANCE IN THE VICINITY OF HANFORD FOR DECEMBER 1968. Wooldridge, C. B. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 5, 1969. Contract AT(45-1)-1830. 17p. Dep. CFSTI.

The concentrations in the environs of most radionuclides of Hanford origin continued to be within the expected range of variation. An unusual increase in atmospheric beta activity in mid-December was attributed to regional fallout. (auth)

**29464** (BNWL-983) EVALUATION OF RADIOLOGICAL CONDITIONS IN THE VICINITY OF HANFORD FOR 1967. Wooldridge, C. B. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1969. Contract AT(45-1)-1830. 87p. Dep. CFSTI.

At Hanford, controlled releases of a variety of low-level radioactive wastes are made to the Columbia River, to the ground, and to the atmosphere. The major source of low-level wastes released to the environment in 1967 continued to be reactor cooling water discharged to the Columbia River. Evaluation of the combined offsite effects of all radioactive waste releases during 1967 showed that concentrations of radionuclides in the environs and radiation doses received by nearby population groups were well within accepted limits. As in previous years, estimates were made of the whole body, gastrointestinal tract, and thyroid doses and the annual intake of bone-seeking nuclides. Population groups considered included Maximum Individuals and typical Richland residents as in previous years, and for the first time average Richland residents. Diet information accumulated from plant employees permitted calculation of both average dose values and dose distribution for Richland residents. The only population dose estimate exceeding one-tenth of the appropriate limit was 12% of the Maximum Permissible Rate of Intake to the bone of a hypothetical Maximum Individual, with $^{32}P$ contributing 99% of the estimated dose and Columbia River fish the major source of intake. Primarily because of the 1966 reactor outage, some 1967 dose estimates exceeded 1966 estimates, but not 1965 values. (auth)

**29465** (CONF-448-36) INTERPRETATION OF DATA RELATING TO PLUTONIUM CONTAMINATION. Jeanmaire, L.; Patti, F.; Audren, M. L. Translated by R. R. Inston (Atomic Energy Research Establishment, Harwell, Eng.), from pp 617-28 of [STI/PUB-84(Vol.2)]. 17p. (SM-52/29).

From IAEA Symposium of the Assessment of Radioactive Body Burdens in Man, Heidelberg.

Data for Pu levels measured in various samples after heavy contamination through the skin and the progress of elimination during the year following contamination are reported. Data resulting from measurements after very slight contamination, and an attempt to interpret them are also presented. (auth)

**29466** (CONF-690406-10) EFFECTS OF THE MARINE BIOSPHERE, HYDROSPHERE AND GEOSPHERE UPON THE SPECIFIC ACTIVITY OF CONTAMINANT RADIONUCLIDES. Lowman, F. G.; Martin, J. H.; Barnes, S. S.; Ting, R. Y. (Puerto Rico Nuclear Center, Mayaguez). [1967]. Contract AT(40-1)-1833. 20p. Dep. CFSTI.

From Symposium on Public Health Aspects of Peaceful Uses of Nuclear Explosives, Las Vegas, Nev.

The environmental and biological factors that influence and alter the specific activities of the radionuclides ejected from a nuclear excavation in Western Panama or Northwestern Columbia are discussed and the ratios of specific activity to maximum permissible specific activity (SA/MPSA) are calculated. These ratios were used to determine which of the radionuclides produced in the fallout and the cloud following the detonation provided potential hazards to man. Of the 72 radionuclides produced in amounts greater than 1 mCi/megaton of explosive yield, 23 would be ejected at specific activities greater than those allowed in man (SA/MPSA greater than one). The specific activities of these 23 radionuclides would be reduced in marine waters (Gulf of San Miguel) by; physical radioactive decay, isotope dilution by the corresponding stable element in seawater, and coprecipitation into or adsorption onto the bottom sediments. Knowing the radioisotope, its half life, and the SA/MPSA ratio, the days required for the nuclide to dilute to MPSA without environmental dilution was calculated. The grams of the corresponding stable elements in the water of the Gulf of San Miguel were determined and finally the depth of sediment in the Gulf of San Miguel required to dilute each radioisotope to MPSA at 0 and 30 days postshot was calculated. These calculations were based on the assumptions that 50% of the fallout would fall into the Gulf waters and that the detonation was a 1 megaton shot. The 23 radioisotopes involved are discussed in detail in relation to their individual characteristics and the hazards each presents to man. Factors such as volume flow, seasonal variations, and currents are also discussed in relation to the distribution of the radioisotopes in marine waters and the effect that this distribution has on specific activities. (E.R.B.)

**29467** (COO-1500-10) SURVEY OF BIOASSAYS FOR URANIUM MINERS. Gotchy, Reginald L. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). June 1968. Contract AT(11-1)-1500. 175p. Dep. CFSTI.

Concentrations of RaD ($^{210}Pb$) and RaF ($^{210}Po$) were measured in the urine, feces, blood, hair, and whiskers of approximately two dozen people associated with the operation of the Schwartzwalder uranium mine near Golden, Colorado. The results of the study supported the hypothesis that analyses of RaD and RaF in biological samples can be used to evaluate and regulate occupational exposures of uranium miners to the short-lived progeny of radon-222. Although RaD and RaF concentrations in the urine and feces of uranium miners were much higher than those in nonexposed humans, there was no evidence of a correlation between bioassay data and mean occupational exposure. Blood concentrations of RaD and RaF showed a correlation with mean exposures of uranium miners. Power functions relating mean working levels ($\overline{WL}$) of exposure with RaD and RaF levels in blood are presented and discussed. Good correlations were found between estimated $\overline{WL}$ and RaD and RaF activities in hair and whisker samples. All correlations were significant at the one percent level. The bioassay data indicated that the contribution of RaD and RaF from natural sources in Colorado may result in significant errors when attempting to estimate low-level occupational exposures from the observed RaD and RaF levels in bioassay samples. Regression analyses performed on RaF data for hair and whiskers that were corrected for the estimated background levels showed an improved fit. Problems involved in the determination of background levels of RaD and RaF for uranium miners, and a possible solution are discussed. (C.O.)

**29468** (DPST-69-30-1) EFFECT OF THE SAVANNAH RIVER PLANT ON ENVIRONMENTAL RADIOACTIVITY. Semiannual Report, July-December 1968. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Mar. 1969. Contract AT(07-2)-1. 19p. Dep. CFSTI.

Results are presented of the environmental monitoring program for the period July 1 through December 31, 1968, for the atmosphere, vegetation and food, milk, and water. The quantity of radioactive waste released by the Savannah River Plant to its environs was, for the most part, too small to be distinguished from natural background radiation or was obscured by fallout from offsite sources. (auth)

**29469** (EUR-3944) RADIOACTIVE CONTAMINATION OF FOODSTUFFS IN THE COUNTRIES OF THE COMMUNITY IN 1966. (European Atomic Energy Community). 1968. 66p. (In Several Languages). Dep.

This report contains measurement data on the radioactive contamination of foodstuffs in the Community countries in 1966. The data relate to the radionuclides $^{90}Sr$ and $^{137}Cs$. Tables and graphs illustrate the pattern followed in the course of the year. The average milk contamination for the Community is compared with that of the United States, Canada, and the United Kingdom. An estimate is given of the strontium-90 intake. For 1966 this intake averages 6,430 pCi of strontium-90, which corresponds to 24.3 pCi/gCa in the diet. Results obtained with the comparative study of the radioactive contamination of the total diet of adolescents in the Community are also given. (auth)

**29470** (EUR-4212) TREND OF THE ENVIRONMENTAL RADIOACTIVITY IN THE PERIOD 1962-66 AND CONSEQUENCES ON THE RADIOACTIVE CONTAMINATION IN FOOD. Stievenart, Cl.; van der Stricht, E. (European Atomic Energy Community). Oct. 9, 1968. 56p. (In French). Dep.

From data supplied to the Commission, a report has been compiled giving an overall picture of the radiological situation in the Community countries in the period 1962-66. It traces the trends in the air, fallout and food contamination levels recorded and assesses the implications of these for man. The influence of regional variations in diet on the intake of strontium-90 are also taken into account. An estimate of the mean dose to the population as a whole is given. The transfer of radioactive contamination in the biosphere has been studied using the collected data. The report presents firstly, the results of a study of the relation between radioactive contamination deposited on the ground, radioactive contamination of the air and amount of rainfall and secondly, a re-evaluation of the relation between the strontium-90 and cesium-137 contamination of milk and the cumulative deposit and recent fallout. (auth)

**29471** (FMB-68-7) EFFECT OF RADIOACTIVE FALLOUT ON THE PASSAGE OF MOBILE TROOPS. Pretre, S. (Forschungsinstitut fuer Militaerische Bautechnik, Zurich (Switzerland)). Oct. 1968. 14p. (In French). Dep.

In contrast to the problems of the civilian population remaining in a contaminated zone following a nuclear disaster, the chief problem for mobile troops is that of crossing the contaminated zone. Principles involved in solving this problem are discussed. A preliminary exploration of the radioactive region should be made by helicopter and the terrain divided into four zones: very dangerous, dangerous, heavily contaminated, and moderately contaminated. Tables are presented to show times of crossing the contaminated zones following the disaster in relation to the degree of risk. (H.L.W.)

**29472** (KURRI-TR-34) A REPORT ON THE SYMPOSIUM ON RADIATION ACCIDENTS IN 1967. (Kyoto Univ. (Japan). Research Reactor Inst.). 1967. 53p. (In Japanese and English). Dep.

The symposium on radiation accidents was held at the Kyoto University Research Reactor on January 28, 1967. The reports presented at the symposium are given in the form of individual summaries: an outline of the radiation accidents; radiation accidents as viewed from the Government regulations; instances of contamination by uranium; contamination by $^{106}Ru$; instances of contamination by plutonium; instances of radiation exposure with accelerators; electron-ray burns; instances in the Radiation Center of Osaka Prefecture; problems in universities and colleges; problems in joint use of research institutes. (NSA of Japan)

**29473** (NP-17860) WESTERN NEW YORK NUCLEAR SERVICE CENTER ENVIRONMENTAL SURVEY. Preliminary Report. (New York State Dept. of Health, Albany. Bureau of Radiological Health Services). Sept. 1962. 97p.

Results are presented of a preliminary environmental survey within a 25 mile radius of the proposed Western New York Nuclear Service Center. Information pertaining to population, surface water supplies, agriculture, stream biota, and livestock within the survey range is presented. Data on water, food, and milk sources are given to determine appropriate sampling locations for contamination from the nuclear processing site or burial facilities for radioactive waste. The information is useful in determining future health hazards, adoption of emission control measures, and preparation of emergency plans. (E.R.B.)

**29474** (ORNL-TM-2427) FIRST QUARTERLY PROGRESS REPORT ON THE THEORETICAL SAFETY EVALUATION OF CONSUMER PRODUCTS FROM PROJECT GASBUGGY. Jacobs D. G.; Struxness, E. G.; Kelly, M. J. (Oak Ridge National Lab., Tenn.). Feb. 1969. Contract W-7405-eng-26. 17p. Dep. CFSTI.

A theoretical safety evaluation, undertaken to determine the radiation hazards to various population groups that would use natural gas and other by-products from the Gasbuggy cavity, is described. Descriptions are given of the scope, input data required, and procedures to be used in making the safety evaluation. (L.C.L.)

**29475** (SZS-12/68) $^{90}Sr$ IN SOIL AND $^{90}Sr$ AND $^{137}Cs$ IN PLANTS ON THE TERRITORY OF THE DDR-1966. Bose, Helga (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). June 1968. 38p. (In German). Dep.

The results of $^{90}Sr$ determinations in soil and plant samples taken from the territory of the G.D.R. in 1966 as well as the results of $^{137}Cs$ determinations in mixed ash samples of plants sampled in 1965 and 1966 are reported. The $^{90}Sr$ concentration found in agricultural soils was 37.2 $nCi/m^2$ (1965: 30.0). There was no difference of the $^{90}Sr$ contamination of meadow soils (36.7 $nCi/m^2$) between 1966 and 1965. The investigation of the soil profiles of 3 meadow soils down to a depth of 50 cm showed no increase of the $^{90}Sr$ concentration in the layers below 15 cm. The $^{90}Sr$ contamination of plants continued to decrease. In comparison to 1965 considerable differences were observed for lucern, rye grain, grass, potato herb, red clover and wheat grain. The $^{90}Sr$ content per kg dried matter of these plant materials was 861, 71, 1193, 1558, 1234 and 53 pCi, respectively. Compared to 1965 there was practically no change of the $^{90}Sr$ content of green maize and beets (body and tops) whereas in potatoes and cabbage (head) the $^{90}Sr$ content was about 90%. The estimated ratio of $^{90}Sr$ surface contamination to $^{90}Sr$ total contamination was between 38 and 56%. Fallout retention was between 12 and 45%. The portions of $^{90}Sr$ taken up by plants from soil hardly differed from last year values. The $^{137}Cs/^{90}Sr$ ratio decreased in rye grain, wheat grain and potatoes from 4 (1965) to 3 (1966) and remained constant in grass (about 1). (auth)

**29476** (UCRL-71443) FATE AND IMPORTANCE OF RADIONUCLIDES PRODUCED IN PLOWSHARE EVENTS. Shore, B.; Anspaugh, L.; Chertok, R.; Gofman, J ; Harrison, F.; Heft, R.; Koranda, J.; Ng, Y.; Phelps, P.; Potter, G.; Tamplin, A. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 18, 1969. 65p. (CONF-690406-9). Dep. CFSTI.

From Symposium on Public Health Aspects of Peaceful Uses of Nuclear Explosives, Las Vegas, Nev.

Investigations on the fate and importance of radionuclides produced in Plowshare events are discussed. The following programs are summarized and data are presented in graphic and tabular form. Methods were developed for determining the total maximum internal dose to the whole body and organs of man and the contributions of individual radionuclides to this dose. The close correspondence between measured values and estimated values obtained using these methods confirmed the predictive capabilities of these methods. A high-resolution, anticoincidence-shielded gamma spectrometer with Ge(Li) detectors was developed that is capable of quantitatively analyzing radionuclides with specific activities of as little as 0.02 pico Ci/gm of material either alone or as a part of a complex mixture of radionuclides. It is particularly suitable for rigorous studies of the slow incorporation of low levels of radionuclides into biological or environmental systems. Determination of the total radioactivity released into the environment after a nuclear cratering event has been facilitated by the use of parachute-borne sequential samplers to measure the three-dimensional distribution of radioactivity in the post-shot cloud. Information about the dispersal of the radioactive cloud as a function of extended time and distance will be obtained using direct data where available, and a reconstruction of the transport phenomena will be undertaken. Data were collected from sampling stations on the deposition and redistribution of radionuclides up to several hundred miles away from the shot. A Particle Analysis Program was instituted to obtain a complete quantitative description of the radioactive particle population produced by a specific nuclear event. The metabolism of Plowshare nuclear debris was studied in dogs, pigs, and goats. The dogs and pigs were allowed to ingest debris particles, while in the goats, only inhaled particles were available. The biological availability of debris radionuclides in dairy cattle and the metabolism of these radionuclides in aquatic animals were determined in order to establish the importance of these radionuclides to man through his food chain. Reentry into the detonation site is determined by the persistence of the radionuclides in the site. It was found that tritium was present in all trophic levels of the post-shot ecosystem from the soil substratum to the processes by which organic matter was synthesized in both plants and animals. Finally, the relation between radiation, chromosome aberrations and cancer was investigated. Currently, one invariant has continued to occur in this triad: the existence of a marked excess of E-16 chromosomes. (E.R.B.)

**29477** THE 1967 SYMPOSIUM ON CIRCUMPOLAR HEALTH RELATED PROBLEMS, COLLEGE, ALASKA, JULY 23–28. Arch. Environ. Health, 17: 457-688(Oct. 1968). (CONF-670715).

Separate abstracts were prepared on four papers presented at this conference. Forty additional papers discuss various other health problems in Arctic regions. (C.H.)

*For abstracts of individual papers see: 29478–29480, and 29941.*

**29478** LOOK AT THE FUTURE OF HAZARDOUS CONTAMINATION OF THE CIRCUMPOLAR ENVIRONMENT. Kay, Kingsley (Dept. of National Health and Welfare, Ottawa). Arch. Environ. Health, 17: 653-61(Oct. 1968).

From Symposium on Circumpolar Health Related Problems, College, Alaska. See CONF-670715.

Health hazards created by biological, chemical, and radionuclide wastes are discussed in relation to the exploitation of natural resources of Arctic regions. Health hazards of chemical wastes, particularly pesticides, and industrial wastes from mining and smelting operations are evaluated. Problems of radionuclide wastes involve wastes produced during the mining and smelting of fissionable materials and the high concentration of $^{137}Cs$ from fallout found in food chains in Arctic regions. (C.H.)

**29479** STUDIES OF FALLOUT $^{137}Cs$ IN THE CANADIAN NORTH. Bird, Peter M. (Dept. of National Health and Welfare, Ottawa). Arch. Environ. Health, 17: 631-8(Oct. 1968).

From Symposium on Circumpolar Health Related Problems, College, Alaska. See CONF-670715.

A special study of fallout $^{137}Cs$ in the Canadian North showed that relatively high concentrations do occur in caribou and reindeer and that there is probably a geographical and a seasonal pattern in these levels; that levels in humans are highest in those who consume caribou meat frequently and that average levels in humans so far observed correspond to radiation doses well within the dose limit recommended for individual members of the population; that selected population groups (e.g., caribou eaters) can be much more significantly exposed than the average for the rest of the population; that there is a need for further studies of the relationship between urinary $^{137}Cs$ concentrations and body burdens to permit a more useful interpretation of the urinary $^{137}Cs$ surveillance data; and that the situation warrants continuing study. There is, as yet, no clearly established downward trend in levels despite the absence of significant atmospheric weapons testing for several years. The relatively high $^{137}Cs$ levels which have been observed provide an excellent opportunity for carrying out investigations of the movement of this fission product through the food chain into man. Such information could be of considerable importance in the event of a large-scale resumption of atmospheric weapons testing. (auth)

**29480** FALLOUT RADIONUCLIDES IN NORTHERN ALASKAN ECOSYSTEMS. Hanson, Wayne C. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Arch. Environ. Health, 17: 639-48(Oct. 1968).

From Symposium on Circumpolar Health Related Problems, College, Alaska. See CONF-670715.

Studies of radioactive fallout in Alaskan arctic ecosystems were conducted during the period 1959 to 1967 to define routes, rates, and amounts of several radionuclides in a region where wildlife resources are important to human welfare. Emphasis was placed on seasonal measurements of $^{90}Sr$ and $^{137}Cs$ in all trophic levels of the lichen-herbivore-carnivore food web at Anaktuvuk Pass during the years 1962 to 1967. Cesium-137 concentrations increased by a factor of two at each successive trophic level of the lichen-caribou, reindeer-man, wolf-food chain. This resulted from the unusual capacity of lichens to absorb and retain fallout materials, especially $^{137}Cs$; the utilization of lichens as a basic winter food by caribou and reindeer; and the dependence upon caribou and reindeer for food by northern peoples and wolves. Strontium-90 was less important than $^{137}Cs$ because it was more mobile in lichens and tended to be blocked from appreciable transfer to carnivores by accumulation in bone. Regional and local differences in $^{137}Cs$ concentrations were noted among plant and animal species and among ethnic groups of natives. A definite seasonal cycle of $^{137}Cs$ was found in the biota which illustrated their close relationship to the environment and the simple structure of arctic ecosystems. Cesium-137 concentrations in caribou flesh and Eskimos at Anaktuvuk Pass attained maximum values during spring and summer months, respectively. Unusually high values during 1964 and 1966 were ascribed to caribou migrations from distant winter ranges with greater $^{137}Cs$ levels in lichens than those measured in lichens at Anaktuvuk Pass, and to the subsequent use of these animals by the Eskimos. Radiation exposure of Anaktuvuk Pass Eskimos from $^{137}Cs$ body burdens during each year of the period 1962 to 1966 varied from 59 to 144 millirem, which is of the same order as natural background radiation. Except for brief periods, $^{90}Sr$ ingestion rates via caribou meat was within Range I of the Federal Radiation Council's radiation protection guides. It is concluded that appreciable amounts of fallout radionuclides, especially $^{137}Cs$, will remain in Alaskan biota for several years. The radiation exposure is not now, nor expected to be, hazardous to animals, including man. Continued study is necessary to continue to increase and improve knowledge of the processes involved in radionuclide transfer within Alaskan arctic ecosystems. (auth)

**29481** PATHWAYS OF PENETRATION OF RADIONUCLIDES INTO FRESH WATER MOLLUSKS AND INSECT LARVAE. Marchyulenene, D. P.; Polikarpov, G. G. (Inst. of Physics and Mathematics, Vilnyus, USSR. Inst. of the Biology of Southern Seas, Sevastopol, USSR). Radiobiologiya, 9: 286-9(1969). (In Russian).

It was shown experimentally that during the investigation (two weeks), aquatic invertebrates accumulate radionuclides primarily from the water medium: zebra mussels receive less than 15% cerium-144, ruthenium-106, and strontium-90 with the plankton; chironomids, which feed on silt, absorb cerium-144, ruthenium-106, and cesium-137 from it in negligible amounts (up to 6%), and only strontium-90 up to 63%. (auth)

**29482** ACCUMULATION OF $^{89}Sr$ AND $^{54}Mn$ BY HYPONEISTIC CRUSTACEANS PONTELLA MEDITERRANEA CL. Belyaeva, O. I. (Inst. of the Biology of Southern Seas, Sevastopol, USSR). Radiobiologiya, 9: 329-31(1969). (In Russian).

The coefficients of accumulation of strontium-89 and manganese-54 by euhyponeistic crustaceans, Pontella mediterranea Cl., were found experimentally. The limiting coefficient of accumulation of radiostrontium reaches a value of 6.3 after 30 hrs. The coefficients of accumulation of radiomanganese increased continuously to 390 units, which gives a basis for utilizing the massive form of the Black Sea hyponeiston, P. mediterranea, as a biological indicator for radiomanganese. (auth)

**29483** RADIOACTIVE CONTAMINATION OF THE ENVIRONMENT. Kovacs, Jozsef; Predmerszky, Tibor; Roka, Otto Fiz. Szemle, 18: 305-12(Oct. 1968). (In Hungarian).

Atom bomb tests and the increasing industrial applications of atomic energy present a new hazard for mankind: contamination of the environment. In addition to consideration of natural radiation sources, external irradiation of the body by radioisotopic sources used in medicine and internal exposure resulting from unsealed sources and resulting from fallout particles must be taken into account. Reactor accidents may release large amounts of radioactive materials, including some with long half-lives, which may be accumulated in certain organs, as is the case of $^{131}I$ in the thyroid. Study of the contamination of the atmosphere at various areas revealed that the geographic location of the bomb tests affect greatly the region. Surface waters are contaminated by fallout and by the release of radioactive waste waters from nuclear power plants. These plants represent a potential hazard should a maximum credible accident occur; contamination caused by routine operation is considered a relatively minor factor. In Hungary, the Radiation Protection Department of the Central Research Institute for Physics checks the potential contamination resulting from the operation of research laboratories. (TTT)

**29484** RADIOACTIVITY CONTENTS IN SOME PLANKTON AND SEA WATER SAMPLES COLLECTED DURING THE PERIOD BETWEEN 1960–68 AND THEIR CORRELATIONS. Tassi Pelati, L. (Univ., Parma, Italy); Triulzi, C. Energ. Nucl. (Milan), 16: No. 5, 17-26(May 1969).

Plankton ecology in the Adriatic Sea and in the Ligurian Sea was studied with emphasis on the uptake of fallout radioisotopes by plankton in marine ecosystems. The gross $\beta$ activity of plankton and sea water samples collected at various depths from 1960 to 1968 is reported. The accumulation of $^{90}Sr$ by Ligurian plankton, containing the protozoa Acantharia that has a skeleton containing $SrSO_4$, and by Adriatic plankton, containing no Acantharia, was compared. The content of $^{144}Ce$, $^{155}Eu$, $^{54}Mn$, $^{147}Pm$, $^{125}Sb$, $^{95}Zr$ from fallout and natural $^{40}K$ and $^{226}Ra$ was also measured by radiochemical methods in selected samples of plankton and sea water. The higher level of radioactivity in the Ligurian Sea was attributed to the uptake of $^{90}Sr$ by Acantharia. Radioactivity levels increased significantly following nuclear tests in 1961, reached a maximum during 1963, and decreased progressively from 1963 to 1968. It was concluded that plankton may be used as immediate indicators of enrivonmental contamination by radioactive fallout. (C.H.)

**29485** ASSAY OF $^{90}Sr$ IN HUMAN BONE IN THE UNITED KINGDOM: RESULTS FOR 1967. Medical Research Council Monitoring Report No. 16. London, Her Majesty's Stationery Office, 1969. 26p. 3s.

It is stated that whilst previous reports in this series have only covered six-months periods the present report gives results for a

whole year, enabling more meaningful comparative analyses of the data. Work carried out by the UKAEA in the course of a national survey of the effects of radioactive fallout is first reported, followed by results of assays carried out in Glasgow. Vertebrae were assayed in preference to femora in the UKAEA survey in order to facilitate comparison with the data of other countries. In the Glasgow series the femur was used to preserve continuity with the earlier monitoring results. It is pointed out, however, that only in the adult is there any appreciable difference in Sr content between the various bones of an individual. The most important feature of the results is the lower values recorded over the age range from newborn to adult, reflecting a fall in dietary contamination. The degree of reduction in adults was greater than expected, although it is not yet known whether this is a real effect or due to sampling. Results are given in a series of tables. (UK)

**29486** FALLOUT CONTAMINATION OF HEN EGGS BY $^{90}Sr$ AND $^{137}Cs$. Nezel, K. (Federal Research Inst. for Small Animal Breeding, Celle, Ger.). Z. Lebensm.-Untersuch. Forsch., 133: 205-8(1967). (In German).

Distribution of strontium-90 and cesium-137 from fallout is studied in shells, yolks, and whites of chicken eggs as well as in chicken feed. Discrimination between $^{90}Sr/Ca$ and $^{137}Cs/K$ is investigated during incorporation from feed into eggs. (H.B.G.)

**29487** A SURVEY OF BIOASSAYS FOR URANIUM MINERS. Gotchy, Reginald Lloyd. Fort Collins, Colo., Colorado State Univ., 1968. 162p.
Thesis.

Concentrations of RaD ($^{210}Pb$) and RaF ($^{210}Po$) were measured in the urine, feces, blood, hair and whiskers of approximately two dozen people associated with the operation of the Schwartzwalder uranium mine near Golden, Colorado. The results of the study supported the hypothesis that analyses of RaD and RaF in biological samples can be used to evaluate and regulate occupational exposures of uranium miners to the short-lived progeny of radon-222. Although RaD and RaF concentrations in the urine and feces of uranium miners were much higher than those in nonexposed humans, there was no evidence of a correlation between bioassay data and mean occupational exposure. Blood concentrations of RaD and RaF showed a correlation with mean exposures of uranium miners. Power functions relating the RaD and RaF levels in blood with mean working levels ($\overline{WL}$) of exposure were $Y(pCi/l) = 19.8\ (\overline{WL})^{0.915}$ and $Y(pCi/l) = 24.4\ (\overline{WL})^{1.54}$, respectively. The corresponding correlation coefficients were 0.74 and 0.77. An inverse linear relationship was observed between the RaF to RaD activity ratio in blood and years of work underground. The relationship was: $Y(RaF:RaD) = 4.47 - (0.173)$ (Years underground). The correlation coefficient was 0.83. All correlations were significant at the one percent level. Good correlations were found between RaD and RaF activities in hair and whisker samples and estimated $\overline{WL}$. The power functions relating RaD and RaF in hair were: $Y(pCi/g) = 3.31\ (\overline{WL})^{1.07}$ and $Y(pCi/g) = 7.60\ (\overline{WL})^{1.09}$, respectively. The corresponding correlation coefficients were 0.86 and 0.89. The power functions relating the RaD and RaF in whiskers were: $Y(pCi/g) = 3.74\ (\overline{WL})^{1.08}$ and $Y(pCi/g) = 8.33\ (\overline{WL})^{1.22}$, respectively. The corresponding correlation coefficients were 0.88 and 0.92. All correlations were significant at the one percent level. The bioassay data indicated that the contribution of RaD and RaF from natural sources in Colorado may result in significant errors when attempting to relate the observed RaD and RaF levels in donors receiving low occupational exposures. Regression analyses performed on RaF data for hair and whiskers that were corrected for the estimated background levels showed an improved fit. The corrected regression lines for RaF in hair and whiskers were: $Y(pCi/g) = 4.90\ (\overline{WL})^{1.51}$ and $Y(pCi/g) = 5.67\ (\overline{WL})^{1.00}$, respectively. The corresponding correlation coefficients were 0.94 and 0.92. All correlations were significant at the one percent level. Problems involved in the determination of background levels of RaD and RaF for uranium miners, and a possible solution were discussed. (TSS) (Disser. Abstr.)

**29488** FISSION OF NATURAL URANIUM IN TUMOR AND NORMAL TISSUE. Kukiel, Ewa; Majewski, Czeslaw; Wszolek, Bohdan (Zaklad Anatomii Patologicznej, Poznan, Poland). Patol. Pol., 18: 231-7(Apr.-June 1967). (In Polish).

In view of the observed presence of natural Th and U in kidneys removed surgically because of carcinoma, samples of tumor tissue from non-necrotic sites, as well as tissue adjoining the tumor and normal tissue from the opposite pole of the kidney exhibiting no abnormalities were examined for spontaneous fission tracks of $^{238}U$ present in natural U contained in the tissues. The autoradiographic method used employed Polish film, type $M_3$, with an emulsion 100 $\mu$ thick. In tissue samples assumed to be normal, one fission track of U was recorded; in paraneoplastic tissue, two, and in the tumor tissue, nine U fission tracks per section. On the basis of the results and calculations that are presented it is suggested that the number of fissions in tumor tissue is dependent on neutron emissions. (BBB)

**29489** $^{137}Cs$ CONTAMINATION IN THE MEAT OF CATTLE SLAUGHTERED IN MILAN AND ROME DURING THE PERIOD 1961–1965. Cigna A. (CNEN-CSN, Rome); Pugliese, A.; Scolari, A. Atti. Soc. Ital. Sci. Vet., 20: 585-9(1966). (In Italian). (RT/PROT-(68)9).

The results of measurements of $^{137}Cs$ in meat samples collected during 1961 to 1965 in the districts of Milan and Rome are reported. These results are compared with the corresponding ones obtained in the same period from milk samples collected in the milk processing centers of Milan and Rome. The ratio between pCi/kg of meat and pCi/l of milk is $3.0 \pm 0.2$. (auth)

**29490** $^{63}Ni$ IN MARINE AND TERRESTRIAL BIOTA, SOIL, AND SEDIMENT. Beasley, Thomas M.; Held, Edward E. (Univ. of Washington, Seattle). Science, 164: 1161-3(June 6, 1969).

A previously unreported radionuclide, nickel-63 (half-life, 92 years), produced in the testing of nuclear devices, was measured in biological and environmental samples from areas of the Pacific Ocean and the eastern seaboard of the United States. The concentrations of nickel-63 are low (maximum of 163 disintegrations per minute per gram of dry weight), but this radionuclide may be a useful tracer of oceanic processes because of its long half-life and long residence time in the ocean. (auth)

**29491** AGRONOMIC FACTORS AFFECTING $^{210}Po$ AND $^{210}Pb$ LEVELS IN TOBACCO. I. SOIL AND FERTILIZER. Tso, T. C. (Agricultural Research Service, Beltsville, Md.); Steffens, G. L.; Ferri, E. S.; Baratta, E. J. Agron. J., 60: 647-9 (Nov.-Dec. 1968).

An examination of soils from tobacco-producing areas and fertilizers commercially available for tobacco production revealed that a wide variation in the levels of $^{226}Ra$, $^{210}Pb$, and $^{210}Po$ exists in these samples. Fertilization increased the $^{210}Pb$ and $^{210}Po$ content in the soil. After the production of a tobacco crop, levels of radioactivity were reduced, indicating a removal of these elements by the plants. Twelve soil samples from major tobacco areas including Maryland, North Carolina, South Carolina, Georgia, Tennessee, and Florida were analyzed for $^{226}Ra$, $^{210}Pb$, and $^{210}Po$ contents. Cultural practices for the production of tobacco, especially the amount of phosphate fertilizer applied and the cropping system, contribute to the wide variation of $^{226}Ra$, $^{210}Pb$, and $^{210}Po$ activities found in soils. Different fertilizers vary widely in the levels of these radioelements. Materials other than the nutrient elements in the commercial fertilizer mix may also contribute to the high levels of radiation. The amount of fertilizer applied to the field for a single crop may not be immediately reflected at the radiation level of that particular crop. The continued addition of fertilizer with a high content of radioelements would certainly result in a buildup of these elements in the soil which may become available to subsequent crops. (BBB)

**29492** THE ESTIMATION OF THE $^{90}Sr$ SURFACE CONTAMINATION AND ABSORPTION OF $^{90}Sr$ INTO THE ROOT BY AGRICULTURAL PLANTS WITHIN THE RANGE OF LOCAL FALLOUT FROM NUCLEAR EXPLOSIONS. Reissig, Herbert (Technische Univ., Dresden). Wiss. Z. Tech. Univ. Dresden, 16: 243-8(1967). (In German).

The surface contamination and root uptake of various agricultural crops by $^{90}Sr$ from local fallout after nuclear weapons explosions were evaluated on the basis of empirical assumptions and relations. Relations between the dose yield and surface activity or contamination density were estimated from particle fall velocity vectors, potentially soluble $^{90}Sr$ atom density, mCi of $^{90}Sr/km^2$, and irradiation intensity. The $^{90}Sr$ surface contamination of plants from local fallout was estimated from the fallout retention of plants as a function of particle size, the average dwell time of fallout particles on plants, and empirical factors used for evaluation of $^{90}Sr$ surface contamination of plants including grass, red clover, rye, cabbage, turnip leaves, potato plants, and ensilage within the range of the radioactive track of a 1-Mt nuclear explosion, local fallout at fixed wind velocities, and downwind dosages at distances up to 500 km. The long-term uptake of $^{90}Sr$ from local fallout by plant roots was evaluated from these theoretical parameters and evidence from previous studies. (BBB)

## *Dosimetry and Monitoring*

*Refer also to abstracts 29154, 29165, 29201, 29203, 29235, 29284, 29285, 29309, 29464, 29465, 29476, 29546, 29657, 29672, 29712, 29733, 29743, 29822, 29943, and 30852.*

**29493** (AEC-tr-7020) EVALUATION OF RADIUM EXPOSURE BY MEASURING EXHALED RADON. Toth, Arpad. Translated from Kiserl. Orvostud., 16: 428-38(1964). 21p. Dep. CFSTI.

A method is described for evaluating the $^{226}Ra$ content of man using results of measurements of the $^{222}Rn$ content of exhaled breath. A mathematical formula for use in calculating the approximate $^{226}Ra$ burden from $^{222}Rn$ breath data is included. Methods for the measurement of Rn in breath were developed by studies of Rn absorption and elimination following inhalation of Rn by four healthy human subjects and 10 patients with silicosis. Sources of possible errors are discussed. Radioactive decay was disregarded in these measurements. (25 references). (C.H.)

**29494** (AEC-tr-7021) SURVEYS AND RESEARCH ON INTERNAL EXPOSURE TO PLUTONIUM. IV-3. STUDIES ON PLUTONIUM BIOASSAY: PRIMARILY ON ROUTINE BIOASSAY. Second Research Report, 1966. Tsuboi, Atsushi; Kawamura, Shoichi (National Inst. of Radiological Sciences, [Tokyo] (Japan)). Translated from a report. 23p. Dep. CFSTI.

A method for the rapid bioassay of Pu in urine by the ion exchange method is described. The method requires one to two days for the separation of Pu in urine and an additional day for the complete detection. Another method is described for the treatment of Pu-containing waste liquids involving the use of bentonite as an ion exchanger. The removal of the radioisotope from the bentonite is accomplished by cohesion-precipitation. In tests with $^{141}Ce$, $^{32}P$, and $^{137}Cs$, pH was seen to exert a strong influence on the results of cohesion-precipitation. Finally, a method is described for measuring Pu contamination of skin and in cutting wounds. For this method a detector was designed with resolving power high enough to permit simultaneous measurement of $\alpha$ rays and x rays. Results showed that the measurement of x rays allowed for the discrimination of Pu getting deeper than the point where $\alpha$ rays are measured. (E.R.B.)

**29495** (BARC-389) WHOLE-BODY COUNTING OF URANIUM MINE WORKERS. Hukkoo, R. K.; Katoch, D. S. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 26p. Dep.

A shadow shield whole-body counter was used to carry out measurements of total-body activity of uranium mine workers at Jadugoda, as a part of personnel monitoring program. The changing pattern of distribution of $^{226}Rn$ daughter products along the mid-axis of the body of a control subject was studied. Half-life value of about 50 min for the decay of radon daughters over the head, chest, and abdomen regions were obtained. Results of measurements on about 300 subjects for their total-body burden of $^{214}Bi$ are presented. (auth)

**29496** (CEA-CONF-1239) PROBLEMS POSED IN THE ESTIMATION OF MEDULLARY DOSE ABSORBED BY THE NURSING INFANT AND THE CHILD IN THE COURSE OF A RADIODIAGNOSTIC EXAMINATION. Chemtob, M.; Witmer, G.; Parmentier, N. C.; Lafuma, J.; Lefebvre, J. (European Radiological Association). 1968. 13p. (In French). (CONF-680435-2). Dep.

From Symposium Ossium, London, England.

Various aspects of exposure determinations are considered. It was shown that exposures vary as a function of age and that the emergent dose represents 7 to 10% of the exposure according to the thickness of the infant's thorax. Calculations of the absorbed medullary dose are discussed from the standpoint of theoretical aspects, choice of a mathematical model, calculations of distances traversed by electrons and x rays in medullary tissue, and comparison of results with experimental determinations on phantoms. The importance of determining the absorbed energy at the level of hematological stem cells is pointed out; a knowledge of numerous hematological parameters is implied. (H.L.W.)

**29497** (CEA-R-3707) MATHEMATICAL MODEL FOR GASTROINTESTINAL TRACT DOSIMETRY, AND ITS APPLICATION TO ADULTS. Vacca, Georges; Bazin, Jean-Pierre; Karhausen, Lucien (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb. 1969. 73p. (In French). (EUR-4109). Dep.

A new method is proposed for the computation of the dose delivered to any level of the gastrointestinal tract after ingestion of radioactive substances. The same method is used as that proposed by ICRP. The concentration of the radionuclide during the progression of the meal is the central concept of this model. A graph relates the MPC with the radioactive halflife of the radionuclide and with any level of the gastrointestinal tract of adults. Soluble and insoluble radionuclides are considered. The case of daughter products is discussed in the Appendix. (auth)

**29498** (COO-1500-12) RADIATION DOSIMETRY FOR THE RESPIRATORY TRACT OF URANIUM MINERS. Holleman, Dan F. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). Dec. 1968. Contract AT(11-1)-1500. 140p. Dep. CFSTI.

Factors affecting the radiation dose to the respiratory tract of uranium miners were investigated. These included atmospheric constitution, deposition of radioactivity in the respiratory tract and physiological translocation. Several aspects of the uranium mine atmosphere were considered, such as radon and radon daughter activity concentrations, physical form and activity-size distribution of the radon daughters, relative humidity and air temperature. Activity concentrations were found to be extremely variable; however, the remaining atmospheric factors were reasonably stable. Less than ten percent of the radon daughters were unattached. Total and regional deposition percentages were determined experimentally as well as theoretically. Percent total deposition values for individual radon daughters were 50, 45, and 41 for radium-A, radium-B, and radium-C, respectively, for an average respiration rate of 18 $min^{-1}$ and an average tidal volume of 1.2 liters. The influence of respiration rate and tidal volume upon total deposition was examined. Regional deposition fractions for the nasal cavity, tracheobronchial and pulmonary regions were 22, 15, and 63 percent of the total deposited activity, respectively, for nose-breathing. Physiological translocation of respiratory deposited activity was investigated for various regions of the respiratory system. Results indicated that ciliary translocation was of negligible importance in the dosimetry of inhaled radon daughters. Radiation dose rates to the respiratory epithelium of uranium miners were evaluated by in-vivo $\gamma$-ray counting techniques. The calculated dose per working level month exposure was 0.8 rads/WLM to the basal cells of the tertiary bronchioles (36 micron mucus-tissue depth). The calculated average organ lung dose rate was 0.1 rads/WLM. (C.O.)

**29499** (GAT-R-444) ADMINISTRATION OF AN IN-VIVO COUNTING PROGRAM. Kalmon, B. (Goodyear Atomic Corp., Piketon, Ohio). Aug. 12, 1968. Contract AT(33-2)-1. 14p. (CONF-690103-13). Dep. CFSTI.

From Health Physics Society Midyear Topical Symposium, Los Angeles, Calif.

This report describes the administration of an in-vivo counting program as applied to insoluble uranium compounds with the lung as the critical organ. Criteria for restricting work activities, and for removal from work restrictions, as well as the derivation of the lung burden and the weight of $^{235}U$ equivalent to one lung burden are presented. The methods of in-vivo computation and sample calculations from data from a specific case are included. (auth)

**29500** (INR-P-965) RADIATION QUALITY FACTOR /QF/ DEPTH DISTRIBUTION DETERMINATION IN TISSUE LIKE PHANTOM FOR THERMAL NEUTRONS. Pszona, Stanislaw (Institute of Nuclear Research, Warsaw (Poland)). 1968. 12p. (CONF-681013-13). Dep.

From Symposium on Dosimetry of Low Energy or Short Range Irradiations, Menton, France.

The paper describes a method for quality factor determination in mixed radiation field. The method is based on a tissue equivalent ionization chamber and on a scintillation counter with NE102A scintillator. The performance of such double detector system in thermal neutron field has been analyzed. The quality factor (QF) dependence as a function of depth of phantom (tissue like) in thermal neutron radiation has been determined. The results of measurements and discussion are presented in the paper. (auth)

**29501** (NRC-TT-1361) DEFINITIONS OF THE DOSE EQUIVALENT, THE REM AND THE VALUATION FACTOR. Berger, H.; Harder, D.; Hubner, W.; Jaeger, R. Translated by D. A. Sinclair (National Research Council of Canada, Ottawa), from Strahlentherapie, 131: 143-9(1966). 9p. Dep.

The dose equivalent $D_q$ is the product of the absorbed dose D and a valuation factor q, determined by mutual agreement and characterizing the risk from the different types of radiation in radiation protection work. The rem, originally proposed as roentgen equivalent man, serves for stating dose equivalents instead of the rad, but is identical to the absorbed dose unit rad. Till now these terms have not been closely defined. In the meantime, however, they have found general acceptance and it is necessary to have them approved as a standard. A specification to this effect will be issued by the German Committee on Radiological Standards in the near future. (auth)

**29502** (ORNL-TM-2558) AVKER: A PROGRAM FOR DETERMINING NEUTRON KERMA FACTORS FOR USE IN ENERGY DEPOSITION CALCULATIONS. Solomito, M.; Ritts, J. J.; Claiborne, H. C. (Oak Ridge National Lab., Tenn.). Apr. 15, 1969. 33p. Dep. CFSTI.

The Fortran code AVKER calculates neutron kerma factors which may be used to determine dose or heat generation rates in materials. The program allows the evaluation of the kerma factors for any desired composition that can be made up from elements presently available in the kerma library and for any arbitrary group structure within the energy limits of 0.023 eV to 19.2 MeV. (auth)

**29503** (RA-38) $^{90}Sr$ AND $^{137}Cs$ IN THE HUMAN DIET IN THE NETHERLANDS DURING 1968. Mattern, F. C. M.; Drost, R.; Strackee, L. (Rijks Instituut voor de Volksgezondheid, Bilthoven (Netherlands). Laboratorium voor Stralingsonderzoek). Apr. 1969. 28p. Dep.

Results of measurements of $^{137}Cs$ and $^{90}Sr$ in a number of foodstuffs are reported. The yearly mean of the daily dietary intake of $^{90}Sr$ and $^{137}Cs$ in the Netherlands is estimated as 12.6 and 31 pCi/day. (auth)

**29504** (SFL-A-11) ON THE EXPOSURE OF RADIOLOGICAL EMPLOYEES IN FINLAND DURING 1965-1967. Toivonen, M.; Isola, Aulis (Institute of Radiation Physics, Helsinki (Finland)). Sept. 1968. 7p. Dep.

The personnel monitoring practice and methods used in the Institute of Radiation Physics are presented. Results of personnel dosimetry concerning approximately 50% of persons regularly engaged in radiological work in Finland during 1965 to 1967 are given also. (auth)

**29505** (SZS-19/68) MEASUREMENTS OF GONAD DOSE RECEIVED BY FEMALES FROM DESCENDING PYELOGRAPHY AND RADIOGRAPHY OF THE PELVIS AND OF THE LUMBAR SPINE. Golly, L. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Dec. 1968. 16p. (In German). Dep.

In the roentgendiagnostic department of a large hospital the gonad doses received by female patients from descending pyelography, radiography of the pelvis and of the lumbar spine were measured. The dose determination was performed indirectly, by measuring the surface dose on the patient and the surface and depth dose in a phantom. The mean dose values are 109 to 125 mR for radiography of the pelvis, 425 to 503 mR for descending pyelography and 75 to 105 mR for radiography of the lumbar spine with a statistical error less than 5%. The effect on gonad dose of field size and added filtration is discussed. (auth)

**29506** (THAI.-AEC-21) PROGRESS REPORT ON HEALTH PHYSICS. (Office of Atomic Energy for Peace, Bangkok (Thailand)). 1968. 6p. Dep.

The efficiency of Kodak Type 2 films used in film badges for indicating mixed x-ray and $\gamma$-ray exposure was investigated. It was found that the assumption that the 1 mm tin absorber stopped the x rays completely was invalid and that in the case of an unfavorable exposure to mixed radiations, the error may be as high as a factor of two. For x-ray monitoring alone, the sensitivity of the badge was increased by a factor of two when the aluminum filter was completely removed. Using a 1 mm aluminum filter, it was found that upon exposure to 50 to 100 kVp x rays there was no difference in the sensitivity of the film to primary and secondary rays. For safety in the reactor building and surrounding areas, three procedures are used: radiation surveys using a NaI scintillation survey meter and a cutie pie, swipe tests for detecting surface contamination in production areas, and air sampling in which particulate matter is collected and analyzed using a gamma spectrometer. A study of a micro GM tube was conducted to determine its characteristics with x rays and $\gamma$ rays. It was determined that with proper shielding and a simple constructed high voltage supply, it may be used as a high radiation level survey meter for $\gamma$ rays. With x rays, it was found to be energy dependent between 50 and 250 keV. The instruments presently used for thermal- and fast-neutron monitoring were found to be direction dependent and the accuracy of calibration dependent on the source of the neutrons. The method used for determining $^{134}Cs$ and $^{86}Rb$ activities in the air sampler is presented in the appendix. (E.R.B.)

**29507** (TID-25018) ENVIRONMENTAL MONITORING. Semiannual Report, July 1-December 31, 1968 and Annual Report, 1968. Moore, J. D. (Atomics International, Canoga Park, Calif.). 28p. Dep. CFSTI.

Environmental monitoring at Atomics International is performed by the Operational Safety Unit of the Health, Safety and Radiation Services Department. Soil, vegetation, water, and air are routinely sampled up to a distance of 10 miles from Atomics International property. The environmental radioactivity reported herein is attributed to natural causes and to nuclear weapons testing, rather than to Atomics International operations. (auth)

**29508** (UCRL-18347, pp 155-70) TISSUE ACTIVATION STUDIES WITH ALPHA PARTICLE BEAMS. Maccabee, Howard D.; Madhvanath, Udipi; Raju, Mudundi R. (California Univ., Berkeley).

The positron-emitting activation of tissue by alpha particle beams was studied by using the annihilation gamma-ray coincidence detection technique, and the Anger positron camera. The decay spectrum in tissue was measured following irradiation by 53 MeV alphas and the activation pattern resulting from a 910 MeV alpha particle beam stopping in a tissue-like plastic phantom was visualized. The activation patterns resulting from transmission of 910 MeV alpha beams through a wax head phantom, and the activation pattern in patients' heads resulting from one sitting of the therapeutic pituitary ablation technique were also studied. (C.H.)

**29509** CLINICAL AND DOSIMETRIC ASSESSMENT OF RADIOTHERAPY WITH BEAMS OF HEAVY PARTICLES OF HIGH-ENERGY. Konnov, B. A.; Volkov, A. A.; Voronin, Yu. V. (Central Research Inst. of Roentgen-Radiology, Leningrad). Med. Radiol., 14: No. 5, 68-80(May 1969). (In Russian).

A brief review is given on clinical and dosimetric evaluation of radiotherapy by beams of high-energy heavy charged particles. It is shown that the available data indicate successful treatment of non-tumorous, neurological and blastomatous diseases. The availability of accelerators makes possible radiotherapy by means of protons and $\alpha$ particles and in future by means of heavy ions. Extensive references are included. (R.V.J.)

**29510** PREDICTING RADIATION DOSE EQUIVALENTS FOR POPULATIONS. I. DOSE MODELS AND METHODS OF APPLICATION. Kaye, S. V.; Rohwer, P. S.; Cowser, K. E.; Snyder, W. S. (Oak Ridge National Lab., Tenn.). Contract AT(26-1)-171. Bioscience, 19: 238-41(1969).

Information essential for developing a model to estimate dose to a population following nuclear excavation was divided into 5 categories: inventory of radioisotopes produced and fractions released to the environment, environmental concentration and dilution factors, intake and/or exposure-time factors, biological parameters and habits characterizing a given population being exposed, and dose estimation equations. Using this input information with INREM and EXREM computer codes the potential radiation dose and a calculated-estimated dose were obtained. The equations used to include these parameters in internal and external dosimetry determinations (models) are described. The model programmed for all body organs except the gastrointestinal tract is also described. A generalized expression for estimating accumulated external dose resulting from submersion or exposure to radioactive cloud, water, or ground is discussed. The method used in the systematic search for critical radioisotopes (four steps) is presented. (C.O.)

**29511** FEATURES SPECIFIC TO DOSIMETRIC CHARACTERISTICS OF SOURCES OF LONG-WAVE ROENTGEN RADIATION. Frolova, A. V.; Kolotilova, V. G. (Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol., 14: No. 5, 64-7(May 1969). (In Russian).

Some features specific to the dosimetric characteristics of sources of soft roentgen radiation (10-50 keV) which should be taken into consideration in the elaboration of dosimetric apparatus are outlined. (auth)

**29512** COMPUTERIZED CALCULATION OF DOSE DISTRIBUTIONS FOR RADIOTHERAPY WITH EXTERNAL BEAMS. Ho, C. Y. (International Business Machines Corp., Essex Junction, Vt.); Janney, C. D. Dig. Int. Conf. Med. Biol. Eng., 7th, Stockholm, 1967, 176(1967).

From 7th International Conference on Medical and Biological Engineering, Stockholm, Sweden. See CONF-670808.

An approach to radiation treatment planning using the tumor as the site of the 100% dose level is discussed. With a fixed target-to-tumor distance, the per cent dose at any point within the beam boundary is then expressed in simple equations. A computer program was written to demonstrate the feasibility of this technique for isodose charts from a 2 Mv Van de Graaff x-ray beam. The advantage is that completely computerized calculations can be made independent of patient size or contour and precalculated plans can be prepared for different field combinations. (C.O.)

**29513** DOSIMETRIC CONSIDERATIONS IN $^{60}Co$ ROTATIONAL THERAPY FOR ESOPHAGEAL LESIONS. A COMPARISON OF TRANSIT AND INTRALUMINAL DOSE MEASUREMENT. Goldenberg, David B.; Gopala Rao, U. V.; Lott, Stewart; Digel, Joseph (Johns Hopkins Medical Institutions, Baltimore). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 518-22(Mar. 1969).

When esophageal dosage is measured with a temperature-corrected intraluminal dosimeter and the measurements compared in the same patients with transit-corrected dose measurements, agreement is obtained to within 3 per cent. Because

of patient comfort and the possibility of perforating a diseased esophagus, the transit dose method appears to be the best and most practical means of obtaining such measurements. The wide range of lung correction factors observed would seem to indicate that the application of one standard correction factor in all patients is not desirable. A transit-corrected dose measurement should be made in each case. (auth)

**29514** DOSIMETRY OF THE HUMAN BODY AFTER 17 MeV-BETATRON RADIATION (MEASUREMENTS OF CADAVERS). Unnewehr, Friedrich; Zeh, Hermann (Univ., Marburg/Lahn, Ger.). Strahlentherapie, 137: 14-17(Jan. 1969). (In German).

Measurements were done during irradiation with a 17 MeV-betatron of six cadavers. Radiographs were made at the skin level, under the sternum, beneath the ribs and under their back. The radiographs are studied by film densitometry in order to obtain isodoses curves, which differ from those obtained in phantom measurements. (auth)

**29515** ENERGY TRANSFER TO MATTER BY NEUTRONS. Bach, R. L.; Caswell, R. S. (National Bureau of Standards, Washington, D. C.). Radiat. Res., 35: 1-25(1968).

Calculations of energy transfer (kerma) for neutrons from thermal to 18-MeV energy were carried out for hydrogen, carbon, nitrogen, and oxygen and for ten compounds or mixtures including tissue. All pertinent nuclear reaction processes are included. The calculation demonstrates the importance of (n, charged particle) reaction processes that were neglected in nearly all previous calculations. These processes dominate the energy transfer process in carbon, nitrogen, and oxygen above roughly 10 MeV. (auth)

**29516** RADIOIODINE IN COLORADO DEER AND ELK THYROIDS DURING 1964–65. Whicker, F. Ward; Farris, Gerald C.; Dahl, Adrian H. (Colorado State Univ., Fort Collins). J. Wildlife Manage., 30: 781-5(Oct. 1966).

Levels of $^{131}I$ in thyroids of Rocky Mountain mule deer and elk in Colorado were determined following the reported underground explosion at the Nevada Test Site on April 14, 1965, and following the Chinese tests which occurred on October 16, 1964, and May 14, 1965. Thyroids from 79 mountain mule deer (Odocoileus hemionus) and 11 elk (Cervus canadensis) were obtained from animals collected throughout the 2-yr period and quantitatively assayed for $^{131}I$. Four significant responses in the $^{131}I$ concentrations were measured, with 3 of the peaks being attributed to the 2 Chinese tests and the underground test at the Nevada Test Site which reportedly vented. The other response could not be traced to any announced release of radioactivity. Radioiodine levels subsequent to each peak declined with half-times ranging from 8 to 11 days. Integrated thyroid doses calculated for each response ranged from ~12 to 254 mrad, which are far below the dose required to produce thyroid adenomas. The data demonstrated the high sensitivity of deer and elk thyroids for environmental monitoring of $^{131}I$. (BBB)

**29517** RADIATION BURDEN OF THE PERSONNEL OF A LARGE FACTORY. Bugyi, Blasius. Radiol. Aust., 17: 123-6(1967). (In German).

The estimated x-radiation burden of an industrial clinic population was evaluated for the period 1961 to 1965 on the basis of exposure/10,000 population. In 1959 the average worker received 3.33 x-ray exposures. In 1964 and 1965 the frequency of lung studies was from 1.2 to 1.4/person. The number of gastrointestinal studies was practically unchanged over the 7-yr period, but the total number of x rays increased almost 3 fold. The main increase was in large x-ray studies of the limbs because of traumatic injuries and rheumatological symptoms. The average skin surface and bone marrow doses decreased. Because of the increased number of x-ray studies the total gonadal dose increased. The radiation burden of the blood-forming bone marrow was of particular significance for the working population because of the industrial materials used that were toxic to the bone marrow. The relative changes and trends for these irradiation burdens were charted for the years studied. (BBB)

**29518** NATURAL BACKGROUND GAMMA RADIATION DOSE RATE MEASUREMENTS IN MICHIGAN, COLORADO, AND MINNESOTA. Levin, Sheldon G.; Stoms, Richard K. (National Center for Radiological Health, Rockville, Md.). Amer J. Public Health, 59: 102-9(Jan. 1969).

To study the possible association of congenital malformations with natural background radiation, detailed background radiation measurements were made in three regions of the USA of interest. In selected cities the relative population dose rate was determined by measuring external radiation in each city, assuming that persons living in all of the various cities spend about the same amount of time at home, shopping, and working and that the differences in natural background radiation at various points within a city are less than the differences between the cities. The individual values were obtained in cpm and were then converted to dose rates and averaged for each city. A detailed analysis of the malformation and background data is included in a later report. The average dose rates in the Colorado towns were 11.6 for the lowest and 14.6 μrad/hr for the highest town. The average dose rates in the Michigan towns varied from 6.6 to 9.2 μrad/hr, and those for towns in Minnesota ranged from 8.3 to 9.4 μrad/hr. The ratio of the average μrad/hr for the town having the highest dose rate (Fort Morgan, Colorado, 14.6 μrad/hr) to that with the lowest (Petosky, Michigan, 6.6 μrad/hr) is 2.2 to 1. (BBB)

**29519** LOCAL DOSE MEASUREMENTS WITH FILM DOSIMETRY IN MEGAVOLT THERAPY INSTALLATIONS. Babor, R.; Wachsmann, F. Radiaz. Alta Energ., 7: 201-15(Oct. 1968). (In Italian).

Radiation monitoring of the environment of radiation therapy facilities in Germany are discussed. Dosimetric measurements using film dosimeters are convenient, due to their high sensitivity and their ability to store doses previously absorbed for a long time. The doses thus measured and integrated over a long time are average amounts that result from normal operation of irradiation equipment. The nature of the radiation can be ascertained through the use of analytic filters. The results of such measurements show that the time during which single sections of the walls of the irradiation rooms are hit by direct radiations is shorter than is usually supposed. The attenuation of the primary radiation through a series of scattering processes increases with the distance from the radiation and results in a decrease of radiation dose. (C.H.)

**29520** A BRIEF NOTE ON COMPUTER APPLICATIONS IN RADIOTHERAPY. Emery, E. W. (University Coll. Hospital, London). Brit. Med. Bull., 24: 241-3(Sept. 1968).

Use of computers in radiotherapy, to ensure adequate doses are given to tumor tissue while sparing healthy tissue, is reviewed. To achieve this aim, much work was done in accurately estimating dose distribution throughout the tissues; and, in most treatments for carcinomas, attempts were made to estimate accurately the dose distribution, using multiple-field techniques. This has entailed much mathematical work, and there is a margin of human error that could result in damage to the patient. The advent of computers has enabled this purely mathematical summation to be done more quickly and easily. Early computer studies produced plans that were identical in appearance with those that radiotherapists were using. The computer produced a mass of figures that was easily converted with an X-Y plotter to an isodose distribution form. Computer programs were then worked out to do 3-dimensional planning to allow for the obliquity of x rays used in treatment on some surfaces of the body, and programs were worked out to define the correct radiation distribution of radiogold insertions and Ra implants for radiation therapy. It is now possible to get accurate estimations of the various volumes and areas of tissues of differing density, in any cross section of the body. The computer programs depended on the working out, by the therapist, of the angles, directions, and doses of fields, with computers giving him the results of the estimations. Programs were then improved still further to enable the radiotherapist to outline what he considered to be the optimal dosage for a tumor, and the computer then to work out the number of fields required to give this optimum plan. (BBB)

**29521** RESEARCH AND SERVICE ACTIVITIES ON PERSONAL DOSIMETRY. Busuoli, G.; Cavallini, A.; Rimondi, O. (CNEN, Bologna). Com. Naz. Energ. Nucl., Notiz., 15: No. 4, 54-60(Apr. 1969). (In Italian).

Personal dosimetry is one of the problems most frequently discussed by those concerned with personnel protection. The viewpoint of the CNEN researchers engaged in these activities is explained, stressing the close connections between the research and service activities of the Bologna Health Physics Laboratory. (auth)

**29522** DIAGNOSTIC RADIATION EXPOSURES AND DOSES IN DENTISTRY. II. Collett, William K. (Univ. of Florida, Gainesville). J. Amer. Dent. Ass., 77: 1104-8(Nov. 1968).

The possible biologic effects of ionizing radiation as used in diagnostic dental radiography are considered. The small diagnostic exposures used on patients in dentistry have not been shown to cause the detectable changes that may be caused by massive exposures used in radiotherapy. The report concludes that dental radiographs, made with modern equipment and technics, are safe and are absolutely essential to dental diagnosis and treatment. However, it is pointed out that regardless of how small and seemingly insignificant the radiation exposures may be

at the present time, radiation effects are cumulative. Therefore, even though there is no known change caused by dental diagnostic irradiation, professional judgement is the only basis for determining the frequency and extent of radiographic examination. (BBB)

**29523** THE DETERMINATION METHOD OF THE IRRADIATION DOSE IN PELVIC LYMPHATIC GLANDS AT THE INTRALUMINAL $^{60}$Co IRRADIATION APPLYING THE CONTRAST LYMPHATIC SYSTEM METHOD. Sukimoto, Katsuyuki (Kumamoto Univ., Japan). Nippon Sanka Fujinka Gakkai Zasshi, 20: 1351-60(Oct. 1968). (In Japanese).

Methods for measuring the radiation dose to pelvic lymph glands during $^{60}$Co $\gamma$ radiotherapy of cervical neoplasms are discussed. The effects of the depth of the glands from the body surface and the angle of the radiation beam on the radiation dose received by lymph glands are discussed. (NSA of Japan) (TSS)

**29524** EXTRACORPOREAL IRRADIATION OF THE BLOOD IN LEUKEMIC PATIENTS. Lajtha, L. G. (Christie Hospital and Holt Radium Inst., Manchester, Eng.); Garrett, J. V.; Turner, L.; Gilbert, C. W.; Hainan, K. E.; Easson, E. C.; Nuttall, P. M.; Watson-Williams, E. J.; Keidan, S. E. Brit. J. Haematol., 16: 39-52(Jan.-Feb. 1969).

Theoretical aspects and dose determination were considered in the course of extracorporeal irradiation (ECI) given to 13 patients; 8 had acute leukemia, 1 chronic myeloid leukemia in the acute terminal phase, and 4 chronic lymphocytic leukemia. Three possible situations in which ECI of the blood might be of use in leukemia are considered: (1) Efficient recirculation of leukemic cells between marrow and blood. Unless such recirculation were fast very low irradiation of the blood would be required. (2) If there were no efficient recirculation of the leukemic cells, release of them from the marrow might be inhibited by a high peripheral cell count. (3) If the high peripheral leukemic cell count itself were contributing to the clinical syndrome, depletion of the peripheral cell count might be beneficial to the patient. For the source strength (24 Ci) of the $^{90}$Sr particle irradiator used, the interdependence of blood volume, number of turns of the coil, transit dose, and rad/hr is given. The possibility of effecting a clinical response, even in the absence of an efficient recirculation of leukemic cells was explored by using short-term (1 to 5 days) continuous irradiation with a relatively high total dose of 10,000 to 30,000 rad. This dose was arrived at from assuming a radiation survival curve for human leukemic cells to have a $D_0$ slope of about 160 rad and an extrapolation number of 2. A single dose of 5000 rad would then produce a survival of $10^{-13}$ which would be about the dose that should completely sterilize the blast cells in peripheral blood. Five patients with acute leukemia treated early responded with a reduction in the blast-cell count in the blood which was maintained with chemotherapy. In chronic lymphocytic leukemia the white-cell count and size of the spleen and lymph nodes were reduced, with clinical improvement in three cases. Dose and theoretical considerations offered no evidence that a significant interchange of cells between the blood and the bone marrow occurs in acute leukemia. The results in the treatment of certain cases of early acute leukemia and late chronic lymphocytic leukemia warrant further trials. (BBB)

**29525** CLINICAL APPLICATION OF COMPUTER DOSIMETRY IN INTERSTITIAL RADIUM THERAPY. Castro, Joseph R.; Lindberg, Robert D.; Fletcher, Gilbert H. (Univ. of Texas, Houston). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 165-71(Jan. 1969).

The development of the interstitial radium therapy computer dosimetry program, including the present system (RADCOMP) together with several representative cases, is described to illustrate a few of the problems in the clinical application of the computer dosimetric data. (auth)

**29526** INTERCOMPARISON OF ABSORBED DOSE IN $^{60}$Co TELETHERAPY USING MAILED LiF DOSIMETERS. Pfalzner, P. M.; Malo, Alvarez S. (International Atomic Energy Agency, Vienna). Acta Radiol., Ther., Phys., Biol., 7: 379-88(1968).

A procedure established by the IAEA for absorbed-dose intercomparison in Cobalt-60 teletherapy was tested with the cooperation of 19 radiotherapy centers in six countries. A number of dosimeter capsules containing LiF powder was distributed by mail and, after irradiation with an absorbed dose of 500 rad at a depth of 5 cm in water, the capsules were returned to the IAEA for read-out and evaluation. The results permitted conclusions to be drawn concerning the reliability of the method of intercomparison, and provided an indication of the consistency and range of disagreement existing in both absorbed-dose determination and exposure calibration. Root-mean-square deviations of respectively ±1.4 percent and ±1.8 percent were found for the readings of irradiated control capsules and test capsules. The maximum differences between institutes in absorbed-dose and exposure determination were respectively 15 percent and 9 percent. (auth) (Swed)

**29527** INFLUENCE OF THE SIZE OF IRRADIATION FIELDS IN GAMMA-THERAPY OF MALIGNANT NASOPHARYNGEAL TUMORS. Moskovskaya, N. V.; Novikova, L. V. (Moscow Inst. of Medicine). Med. Radiol., 13: No. 12, 14-20(Dec. 1968). (In Russian).

For the dosimetric evaluation of small-field, multiple-field cross irradiation of the nasopharynx in malignant neoplasms, the chemical method of dosimetry was used. It directly enabled a volumetric picture of the distribution of the ionizing radiation energy in different organs and tissues of the head, as well as the position and proper centration of the beam. The technique referred to of irradiation was compared with the use of 4 × 4 cm fields with more routine methods (6 × 8 cm fields), involving the employment of additional construction of isodoses of ionizing radiation distribution in the frontal and sagittal planes. It was established that the former method of nasopharyngeal irradiation is associated with difficulties in the centration of the beam, but nonetheless the former technique requires less internal doses in irradiation of the head. (auth)

**29528** RECTUM–BLADDER DOSIMETRY IN THE TREATMENT OF 100 CASES OF CANCER OF THE UTERINE CERVIX BY INTRACAVITY $^{226}$Ra AND $^{60}$Co TELETHERAPY. Trappier, Arthur S. (Kings County Hospital Medical Center, Brooklyn). Radiology, 92: 162-3(Jan. 1969).

Historically the treatment of cancer of the uterine cervix has been empirical. Therapeutically it is desired to give a lethal dose to the lesion without causing detrimental side-effects to the neighboring healthy tissue. The doses received by the base of the bladder and the anterior rectal wall are clinically significant. After the insertion and packing of the intrauterine tandem and vaginal ovoids containing the radium-226, rectal and bladder exposures were recorded with a scintillation detector and a ratemeter. The rectum-bladder dosimeter consists of a 10-stage photomultiplier tube, $\frac{3}{4}$ inch in diameter, and a 3-transistor preamplifier. The complete detector unit was mounted in an aluminum housing 1 inch in diameter and $9\frac{1}{4}$ inches long. The detector probe contained a sodium iodide thallium-activated crystal scintillation detector and a light pipe for optical coupling to the photomultiplier tube. The probe had a wall thickness of 55 mg/cm$^2$ and was marked along its length in 1 cm intervals. A 15-microgram radium source encapsulated in 0.5 mm of platinum was used for calibration. The source was placed 2 cm from the probe wall in line with the crystal inactive volume. A jig was used to reproduce the calibration distance and to sterilize the probe. With the probe and source in position, the ratemeter was adjusted to 31,000 CPM. At 2 cm this calibration source gave an exposure rate of 31 mR/hr; thus as 1mR/hr was represented by 1,000 CPM, giving the unit a convenient calibration factor. The vaginal walls were packed anteriorly and posteriorly to increase the separation distances of the bladder and rectum from the radium. Microgram equivalents corresponding to the milligram sources used in the treatment were inserted into the Fletcher after-loading tandems and ovoids. Exposures during 100 consecutive radium insertions were measured at 1 cm intervals from the urethral meatus along the urethra into the bladder. Rectal exposures were measured from the anus in 1 cm intervals along the rectum anterior wall. The bladder exposures ranged from 906 R to a maximum of 2,337 R at 7 cm per radium insertion. The rectal exposures ranged from 639 R to a maximum of 1,604 R per radium insertion at 7 cm. For 100 insertions an average of 75.65 mg of radium was used (corrected to 0.5 mm of Pt), treating for 46.0 hr delivering 3,480 mg/hr. In addition to radium, the whole pelvis is generally treated with 4,000 rads by rotational cobalt-60 $\gamma$. Calculating the teletherapy dose distributions with an IBM 360 digital computer showed that a portion of the bladder and the rectum lie in the 100 per cent zone, some tissues thus receiving over 4,000 rads in addition to the radium exposure. Therefore, the total maximum absorbed dose in muscle in the bladder and rectum respectively was found to be 8,473 rads and 7,069 rads. (auth)

**29529** DOSIMETRY OF AN IMPLANTABLE $^{252}$Cf SOURCE. Oliver, G. D. Jr.; Wright, C. N. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Radiology, 92: 143-7; 135(Jan. 1969).

For radiotherapy small self-contained sources of $^{252}$Cf have theoretical advantages over conventional gamma sources and will allow versatility of treatment with neutrons in a form never before available. From the point of view of dose distribution and quality of radiation, $^{252}$Cf may be a good substitute for radium and other implantable gamma-ray sources, although its shorter half-life is a slight disadvantage. The dosimetry data presented will be used for radiation biology and clinical experiments to evaluate the effectiveness of $^{252}$Cf in radiotherapy. (auth)

**29530** ACCURACY OF DOSIMETRIC CALCULATIONS IN INTRACAVITARY RADIUM THERAPY. Milshtein, R. S. (Scientific-Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol., 14: No. 2, 42-5(Feb. 1969). (In Russian).

In intracavitary and intratissular radium therapy involving the use of linear preparations, it is necessary in a number of cases to determine the dose value in restricted areas. The presented calculations demonstrate in what conditions the linear source could be viewed as pinpoint, etc. (auth)

**29531** EXPOSURE DOSES OF X-RADIATION INCURRED DURING VETERINARY DIAGNOSTIC RADIOLOGICAL EXAMINATIONS. Dixon, R. T. (Veterinary Clinical Centre, Werribee, Victoria). Aust. Vet. J., 44: 299-303(July 1968).

The number of radiographs taken per week has been calculated for a Veterinary School practice for three periods. In the first period the number averaged 35 per week; in the second period, 45 per week and in the third period 64 exposures per week. The exposure dose of x radiation per radiograph was calculated for personnel taking the radiographs in each of these periods. In the first period the exposure dose for the radiologist was 0.183 mrem per radiograph. The conditions in this period approximated those in a practice in which the veterinarian restrained and positioned the animals without additional help. In the second period the dose for the radiologist was 0.16 mrem per exposure, and for one assistant who helped restrain the animals the dose was 0.019 mrem per exposure. The conditions here approximated a practice in which the veterinarian and a trained lay assistant restrain and position the animal. In the third period the radiologist's exposure dose had decreased to 0.044 mrem, and the dose for a radiographer was 0.052 mrem. This approximated the conditions in a practice with two or more veterinarians using trained lay assistants. The average exposure dose for 24 students was 0.093 mrem per exposure, and this figure is considered applicable to owners who hold and position their animals in a veterinary practice. The exposure dose per radiograph to the body of the veterinarian, his assistants, and to members of the public was considered in relation to the maximum permissible dose of radiation. It was recommended that owners be not used to restrain their own animals, and methods of reducing the radiation dose per radiograph to the veterinarian and his assistants were discussed. (auth)

**29532** STUDY OF THE DOSE DISTRIBUTION CLOSE TO AN ARRAY OF POINT SOURCES. Dutreix, A.; Wanbersie, A. (Inst. Gustave Roussy, Villejuif, France. Inst. du Cancer, Louvain, Belgium). Acta Radiol., Ther., Phys., Biol., 7: 389-400 (1968). (In French).

The dose distribution in gynecologic treatments (intrauterine applicators) will not be much influenced by the substitution of point sources for continuous sources if the distance between the sources is kept below 2 cm. This applies for the shape and dimensions of the treatment volume as well as for volumes receiving overdoses. Tables and diagrams are presented for a rapid determination of the reference dose and the dimensions of the treatment volume when using point sources regularly interspaced. A reduction of the distance between the extreme sources leads to no important modification of the treatment volume but necessitates a separate dose calculation. (auth)

## *Radiation Protection*

*Refer also to abstracts 29650, 29848, 29851, 29864, and 29865.*

**29533** (AERE-R-6288) REMOTE HANDLING SERVICES. THE TURRET SUIT: PATENT NO. 974316. May, F. J. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1969. 18p. Dep. CFSTI. UK 4s. 0d.

A description is given of an inflated and free standing plastic suit designed to protect operators when working within the environment of an active-handling cell. (auth) (UK)

**29534** (BNWL-SA-2360) PLOWSHARE RADIATION PROTECTION GUIDANCE. Parker, H. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1969. Contract AT(45-1)-1830. 13p. (CONF-690406-3). Dep. CFSTI.

From Symposium on Public Health Aspects of Peaceful Uses of Nuclear Explosives, Las Vegas, Nev.

It seems appropriate that each Plowshare program be evaluated individually, providing the necessary studies and population considerations, so that the correct dose limit guidance for acceptable conditions may be used. Collection and analysis of environmental exposures and dose data are necessary so that we may learn from experiences and assure safe conditions. Plowshare can be performed safely, but good judgment, sound application of existing radiation protection guidance, and sufficient funding to meet the needs of practical safety programs are needed. A safe approach using the public exposee or the general population dose control limits, as the situation may demand, is necessary to help assure the rapid development of Plowshare programs. (C.O.)

**29535** (CONF-680503-6) RESPIRATOR EFFECTIVENESS IN AN ENRICHED URANIUM PLANT. Caldwell, Roger; Schnell, Edward (Nuclear Materials and Equipment Corp., Apollo, Pa.). [1968]. 20p. Dep. CFSTI.

From American Industrial Hygiene Conference, St. Louis, Mo.

Personal air sampling data were correlated with fecal sampling data for studying respirator effectiveness. Fitting and field testing the respirators, personal air sampling methods, and early fecal clearance as a measure of exposure are discussed. (W.H.K.)

**29536** (EUR-3740) CONFERENCE ON RADIATION PROTECTION, 31 MAY-2 JUNE 1967. June 1968. 80p. (In several languages). (CONF-670552). Communautes Europeennes $2.00.

From Conference on Radiation Protection, Mondorf-les-Bains, Luxembourg.

The three papers given at the Conference on Radiation Protection are presented. The papers, which are included in full, were used as focal points for discussion. The topics covered were the evaluation of internal contamination and its treatment, the attitude of the medical service in case of exposure of nuclear workers, and the risks to personnel of nuclear installations. (J.S.R.)

**29537** (FOA-4-4371) OVERPRESSURE SUIT OF PVC-PLASTIC FOR WORK WITH RADIOACTIVE MATERIALS. Wahlstroem, L. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Sept. 1968. 23p. (In Swedish). Dep.

An overpressure protection suit for radioactive work is described. It is made of polyvinyl chloride and consists of trousers and jacket. The latter is welded to the trousers after it has been taken on. Two parallel connected vacuum cleaners supply up to four suits with air. The crew keeps in contact by a telephone circuit. (Swed)

**29538** (ORNL-tr-2056) CAUSES OF ACCIDENTS NEAR ACCELERATORS AND RADIATION PROTECTION MEASURES. Joffre, Henri; Vialettes, Henry (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report CEA-R-3443. 25p. Dep. CFSTI.

Some typical accidents mentioned in bibliography or that have happened in C.E.A. Research Centers are presented. The accidents are analyzed to determine the main cause. A centralized control for security, detection and signalling devices used near every important accelerator is described. (auth)

**29539** (SZS-20/68) THE OCCUPATIONAL RADIATION EXPOSURE IN THE GERMAN DEMOCRATIC REPUBLIC IN 1966. Brasack, G. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Dec. 1968. 18p. (In German). Dep.

Data of the central personnel dosimetry in the German Democratic Republic are presented for 1966. A total of 25,079 persons were monitored by the Radiation Protection Center with film badges. Altogether, 985 monthly over-exposures (more than 0.4 rad) were recorded. In 37 cases the quarterly dose (3 rad) was exceeded during one month, but only 21 of those were real over-exposures. The greater part of over-exposures is attributable to the insufficient attention to safety regulations. Furthermore, the results were analyzed according to the type of institution, type of employment, and age of employees. (auth)

**29540** APPARATUS FOR REDUCING RADIATION EXPOSURE OF AEROPLANE PILOTS. Schlobies, Christoph (to Entwicklungspring Sued GmbH). British Patent 1,142,924. Feb. 12, 1969. Priority date Sept. 19, 1966, Germany.

An apparatus is described for the reduction of radiation exposure to airplane pilots from a nuclear explosion. The apparatus comprises a number (e.g., 4) of gamma-ray detectors arranged in the outer skin of the airplane, a comparison device for the detector signals, and a computer actuating the controls to turn the airplane to the position of maximum gamma-ray absorption, resulting in protection of the pilot. (D.L.C.)

**29541** PRESENT KNOWLEDGE OF THE EFFECTS OF RADAR WAVES ON LIVING ORGANISMS AND APPROPRIATE PROTECTIVE MEASURES. PART 2. Busco, R.; Comignani, L. Riv. Med. Aeronaut. Spaz., 30: 718-57(Oct.-Dec. 1967). (In Italian).

Aspects dealt with include: hazards associated with the effect of microwaves (dangers of ionizing radiation, radioactive substances, combustion and explosion; risk of poisoning; the influence of environmental factors on safe exposure level; harmful effects of protective clothing; problems concerning accommodation of the retina to darkness). The paper concludes with considerations

on: exposure criteria; protective measures and equipment; protection against ionizing radiation; the density of radiant energy at aerials; measurement of radiofrequency radiation doses and delimitation of energy density zones; and medical supervision of personnel. (Occup. Safety and Health Abstr.)

**29542** THE LASER: ITS PRINCIPLES, ITS DANGERS, AND PROTECTIVE MEASURES. de Herrypon, H. Arch. Mal. Prof. Med. Trav. Secur. Sociale, 29: 315-18(June 1968). (In French).

The physical characteristics of lasers are described and the various types of apparatus are classified according to their design or method of operation. Dangers associated with lasers include: electrocution from high voltage; accidental release of liquid nitrogen; thermal effects on the eyes, depending on the method of operation and the length of impulse (photocoagulation of the retina with complete loss of sight at the point affected); thermal effects on the skin; mechanical effects caused by the generation of coherent elastic vibrations. Protective measures relating to workplaces include: adequate ventilation and lighting; protection against high voltage; elimination of reflective surfaces. Safety devices are described. Measures directed at personnel include: training; protection of the eyes by special types of glasses; skin protection; and regular medical supervision. (Occup. Safety and Health Abstr.)

**29543** THE LENGTH OF RETENTION OF RADIOACTIVE METAL IONS ON THE SKIN. Ziegler, G.; Luethy, H.; Gaehwiler, B. (Univ., Basel). Dermatologica, 137: 259-62(1968). (In German).

Skin retention times of $^{203}Hg$, $^{58}Co$, and $^{51}Cr$ (as dichromate) ions were studied with and without hand salves designed to protect against eczema produced by exposure to cement. Removal of the radioisotopes from skin was measured by scintillation counting of the residual radioactivity following various treatments. The metallic salts remained on the skin for many days, although the amounts decreased rapidly from the initial values. There was no difference in the retention of the radioisotopes on the skins of persons who were eczematic or nonallergic to cement. The protective ointment used increased the loss of $^{51}Cr$ radioactivity from skin. The effect of the ointment was principally due to a mechanical elimination of metallic ions. However, the last traces of $^{51}Cr$ were removed only by combination of the metal ions with an ion exchanger contained in the ointment. (BBB)

## Safety Procedures

**29544** (THAI.-AEC-1(Rev.1)) RADIATION SAFETY MANUAL. (Office of Atomic Energy for Peace, Bangkok (Thailand)). Dec. 1968. 44p. Dep.

This Manual contains the rules and procedures relating to radiation safety that are to be followed in all Thai AEC operations. These rules and procedures were prepared to meet the requirements of the Thai AEC Research Center, but they should be regarded as a guide for other centers in Thailand working with radioisotopes. The organization of radiation safety and the rules and procedures that are to be followed by all radiation workers at the Research Center are outlined in Section 2. The special safety aspects involved in work with the Thai Research Reactor are covered in Section 3. Section 4 provides for the case of fire in radiation areas, and Section 5 establishes the basic procedures to be followed in an emergency involving radiation hazards. (auth)

**29545** (TID-24918) RADIOLOGICAL EMERGENCY OPERATIONS. Instructor's Manual. (Reynolds Electrical and Engineering Co., Inc., [Mercury], Nev. Radiological Sciences Dept.). [July 1968]. Contract AT(29-2)-162. 219p. Dep. CFSTI.

This Instructors' Manual provides guidance and information for the preparation and conduct of a course in Radiological Emergency Operations. This course includes the study of emergency response organization, emergency radiation monitoring theory and applied techniques, radiation safety practices, emergency equipment and procedures, nuclear weapons accident hazards, and legal and public information considerations. It includes: a schedule for conducting the entire course in ten days, a list of publications recommended as texts for the course, information on where to obtain the recommended texts, a bibliography of references, movie films for use in this course and where to obtain them, outlines for each class period, sample quizzes and final examination, and suggested course evaluation and review sheets. (auth)

**29546** (UR-49-1065) DOSE-TIME RELATIONS FOR INDUCTION OF LUNG CANCER IN URANIUM MINERS. Blair, H. A. (Rochester Univ., N. Y.). Mar. 4, 1969. 16p. (CONF-690404-1; SM-118/4). Dep. CFSTI.

From Symposium on Radiation Induced Carcinogenesis, Athens, Greece.

Lack of data on the concentration of radon and daughters in the air inhaled by uranium miners has made it difficult in the past to establish radiation dose and time factors for induction of lung cancer. Recent determinations by others of $^{210}Pb$ in the bones of miners who died of cancer provide, however, a new approach. Because $^{210}Pb$, a decay product of radon, accumulates in bone but is also excreted, its concentration, after prolonged exposure, will approach an equilibrium which is a measure of the rate of exposure. It is shown that the $^{210}Pb$ levels in bone at the end of mining are as closely proportional to existing measured and estimated exposure rates to radon as can be expected. It is reasonable, therefore to use $^{210}Pb$ levels in bone as measures of prior exposure rates. When this is done a graph of survival times from beginning of exposures against reciprocal of $^{210}Pb$ shows that lung cancer in man exhibits the two types, early and late, previously revealed in bone cancer in dogs and skin cancer in rats. When the dose is high, death follows initiation of cancer in about 7 years. When the dose is low, the usual case, there is an additional latency of 16 years so the time from attainment of initiating dose to death is 23 years. The initiating dose for the high dose type is about 65 pCi $^{210}Pb$ per gram years and for the low dose type about 10 pCi per gram years which in terms of exposure is about 400 working level months, WLM, as working level, WL, is currently defined. Of the derived parameters the total low dose development time of 23 years is fairly accurate. The high dose development time of 7 years is less certain. The initiating low dose 10 pCi per gram years is probably moderately accurate but its counterpart 400 WLM less certain. The high initiating dose is poorly determined. Twenty-three lung cancer cases were involved in this study. Additional cases along with additional environmental and other measurements should increase the accuracy of the dose-time parameters. (auth)

## Civil Defense

**29547** (SC-DR-68-345) GENERALIZED SNAP SAFETY ANALYSIS MODELS. Smith, R. E.; Hall, I. J. (Sandia Labs., Albuquerque, N. Mex.). Sept. 1968. Contract AT(29-1)-789. 37p. Dep. CFSTI.

This report presents a general mathematical approach for evaluating the risk of using radioactive materials in space missions. Two basic safety models, that encompass the general safety criteria philosophies concerning the number of people receiving a specified amount of radiation and the total radiation received by the population, are derived. Each model is applicable to presently conceived hazard situations that may arise from the use of radioactive materials. (auth)

**29548** RADIOLOGICAL DEFENCE IN CANADA. EMO (Emergency Meas. Organ.) Dig., 8: 1-3; 16(Oct.-Nov. 1968).

The phenomenon of fallout and the planning, organization, procedures, and training necessary to implement an effective radiological defense system are described. Several national and international councils on radiological defense are discussed— among them, the Canadian Interdepartmental Radiological Defence Working Group, which studies the problems of radiation hazards and provides guidance to governments and industry on the total requirement for Radiological Defence. (Arms Contr. Disarmament)

**29549** STATE OF RADIATION PROTECTION IN 1968. Rajewsky, Boris (Max-Planck-Institutes fuer Biophysik, Frankfurt am Main). VDI (Ver. Deut. Ing.) Z., 111: 183-4(Feb. 1969). (In German).

While reliable measuring devices exist for persons involved in the radiation industry, corresponding techniques have not been satisfactorily developed for the general population from a civil defense standpoint because of the requirements for low costs and simplicity. In this respect, the present state and the future potential of color changes in glasses, thermofluorescent effects, and chemical alterations are discussed. (H.B.G.)

## Legal Aspects

*Refer also to abstracts 29519, 29931, and 29940.*

**29550** (MORP-68-3) SYSTEM FOR THE REGISTRATION OF RADIATION SOURCES. Miller, Lois A. (National Center for Radiological Health, Rockville, Md.). Mar. 1968. 84p.

A system for the registration of radiation sources was developed by the X-Ray Section, Medical and Occupational Radiation Program, National Center for Radiological Health, as a guide for state radiological health programs; a complete register of sources is the hopeful outcome of this project. The system was divided into four

distinct phases: administrative decisions, program design, field implementation, and data utilization. A discussion of each of these phases including a presentation of suggested forms, flow diagrams, and frequency distribution tables is presented. In general, the report describes an operational system for registering radiation sources utilizing automatic data processing equipment that is available in nearly all states. (C.O.)

**29551** (SZS-11/67) SUMMARY OF NEW REGULATIONS OF THE STATUTE OF THE NATIONAL CENTER FOR RADIATION PROTECTION. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Aug. 1967. 46p. (In German). Dep.

The organization and duties of the National Center for Radiation Protection of East Germany are described. The organization was established by Article I and the statute for the organization of the Center. Article I is presented in full. (J.S.R.)

*For abstracts of individual sections see: 29552–29554.*

**29552** (SZS-11/67, pp 5-22) SURVEILLANCE OF OCCUPATIONALLY RADIATION-EXPOSED PERSONNEL IN THE DDR. Sitzlack, G. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (In German).

The surveillance of occupationally exposed personnel by medical and physical surveillance services of establishments and the government is explained as a part of the total system of radiological protection. The relationship between individuals, their environment, and the type of installation is considered. Special attention is given to the medical and physical surveillance programs for occupationally exposed personnel conducted by the Radiation Protection Center of the German Democratic Republic. (auth)

**29553** (SZS-11/67, pp 23-39) RADIATION PROTECTION AND ITS LEGAL REGULATION IN THE DDR. Iffiaender, G. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (In German).

The statutes regulating radiation protection in the Peoples Democratic Republic of Germany are summarized chronologically. (J.S.R.)

**29554** (SZS-11/67, pp 40-6) INSTRUCTIONS FOR RADIATION-PROTECTION TESTS AND RADIATION-PROTECTION PERMITS FOR EQUIPMENT FOR SOURCES OF CONTINUOUS RADIATION, FOR EXAMPLE CONDITIONS OF ACTIVITY OF CONTAINERS. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (In German).

In implementation of the radiation protection ordinance of June 10, 1964, of the Peoples Democratic Republic of Germany, guidelines were established for radiation protection testing and radiation protection permits for the use of sealed radiation sources. These guidelines concern the range of applicability of the guidelines, the definitions, responsibility, radiation protection construction tests, and construction permits for radiation devices in series, permit tests for radiation devices in individual and mass production, permit testing for imported radiation devices, supplemental testing, and maintenance of the tests established in the guidelines. (J.S.R.)

**29555** A LITTLE KNOWN NUISANCE: VHF ELECTROMAGNETIC RADIATION FROM RADAR ANTENNAS. Joly, R. Trav. Secur., No. 9, 390-5(Sept. 1967). (In French).

Although the use of radar transmitters is becoming more and more widespread, little is known about the relevant hazards, and no relevant statutory provisions have yet been enacted in France. A review on the physical characteristics of VHF radar transmissions was made and the physiological effects of VHF waves were studied. When such waves are absorbed by the human body, they produce internal heat, the extent of which depends on various factors (wave length, intensity and duration of radiation). Studies are under way to determine the radiation power theshold below which this hazard does not arise. Specific subjective, neuro-vegetative or humoral disorders of ill-defined origin were observed in persons with a history of protracted exposure. In addition to the observance of permissible exposure limits, elementary precautions must be taken; in particular, protective shielding and metal mesh goggles should be used. Routine medical examinations of radar station staff should include eye and blood tests, and possibly electroencephalograms. (auth) (CIS)

**29556** X-RAY EXAMINATION FOR MEDICO-LEGAL PURPOSES. Shanks, S. C. (University Coll. Hospital, London). Radiol. Clin. Biol., 37: 357-65(1968).

The use of x-ray examinations as proof of injuries before compensation by casualty insurance companies and also by physicians engaged in industrial medicine is discussed. It is pointed out that this practice results in unnecessary exposure of many patients to the small doses of x radiation received during diagnostic radiography. However, a negative x-ray report sometimes has a great therapeutic effect on the patient, and it also provides justification for physicians sending neurotics and malingerers back to work. Data on the genetic and somatic effects of various doses of ionizing radiation and the radiation dose received by man during diagnostic radiography are reviewed briefly. It is concluded that diagnostic radiographic examinations are justified in the management of industrial accidents where the possibility of bone fractures exists. (C.H.)

**29557** LEGAL AND INSURANCE MATTERS. Jaeger, Wolf-Eckhard (Bundesministerium fuer Wissenschaftliche, Forschung, Bad Godesberg, Ger.). VDI (Ver. Deut. Ing.) Z., 111: 185(Feb. 1969). (In German).

In Germany, a general solution of the legal and insurance aspects concerning atomic energy is presently inadvisable or impossible. However, in accordance with international regulations, certain directives are proposed with respect to production and transportation of reactor fuel elements, the establishments of atomic power plants, and the legal aspects of atomic powered ships entering foreign ports. (H.B.G.)

## Medicine

*Refer also to abstracts 29096, 29153, 29295, and 29459.*

**29558** (ACRH-30) SEMIANNUAL REPORT TO THE ATOMIC ENERGY COMMISSION. Gottschalk, Alexander (ed.) (Argonne Cancer Research Hospital, Chicago, Ill.). Sept. 1968. Contract AT(11-1)-69. 144p. Dep. CFSTI.

Sixteen publications derived from research at Argonne Cancer Research Hospital are included in the report. Seven papers were within the scope of NSA and separate abstracts were prepared for each. A list of the staff publications for the research year is included. (C.O.)

*For abstracts of individual papers see: 29309, 29390–29392, 29599, 29819, and 29820.*

**29559** (NEIC-RR-33) REPORT OF RESEARCH WORK DURING 1967. Jasinskiego, W. (Instytut Onkologii, Warsaw (Poland)). 1968. 147p. (In Several Languages). Dep.

Brief summaries of arbitrarily chosen publications that evolved from research at the Institute are presented. Topics included statistical analysis of death rate from cancer in Poland during 1961; results of radiotherapy of uterine, bowel, and other carcinomas and subsequent side effects; dosimetry of radiation to various areas of the body during such therapy; the correlation between child delivery and cervical carcinoma; and basic research on physiological processes in rat liver cells. (C.O.)

**29560** XIII INTERNATIONAL CONGRESS OF DERMATOLOGY, MUNICH, JULY 31–AUGUST 5, 1967. VOLUME 1. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. 868p. (In Several Languages). (CONF-670719-(Vol.1)).

Four separate abstracts were prepared for inclusion in NSA. There are numerous other papers in this first volume covering the general themes of: Cancerous state, precancerous state, and pseudocancers of the skin (except sarcomas and melanomas); corticosteroids in dermatology; contact dermatitis; virus infections of the skin and mucosa; current problems in syphilis; cutaneous manifestations of circulatory disorders of the legs; and regeneration and transplantation of the skin. In addition symposium reports on: genodermatoses; pyodermatitis; dermatoses, nervous system and psychotic origin; and andrology are given. (C.O.)

*For abstracts of individual papers see: 29658, 29758, 29847, and 29848.*

**29561** XIII INTERNATIONAL CONGRESS OF DERMATOLOGY, MUNICH, JULY 31–AUGUST 5, 1967. VOLUME 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. 910p. (In Several Languages). (CONF-670719-(Vol.2)).

Thirty-two separate abstracts from the second volume on the dermatology congress are included in NSA. Numerous other papers were presented in the general categories of malignant reticuloses and lymphomas; mycoses; malignant melanomas; physiology of the skin; radiation effects on the skin; immunology in dermatology; skin and internal disease; bullous dermatoses; mycobacterial infections of the skin; iatrogenic diseases in dermatology; film presentations and exhibitions. (C.O.)

*For abstracts of individual papers see: 29354–29358, 29578–29580, 29613, 29659–29664, 29709, 29713, 29714, 29759–29763, and 29838–29846.*

**29562** DIGEST OF THE SEVENTH INTERNATIONAL CONFERENCE ON MEDICAL AND BIOLOGICAL ENGINEERING,

STOCKHOLM, SWEDEN, AUGUST 14–19, 1967. Jacobson, Bertil (ed.). Dig. Int. Conf. Med. Biol. Eng., 7th, Stockholm, 1967, 1-527(1967). (CONF-670803).

Separate abstracts were prepared for 9 of the 481 papers presented. The remaining 472 pepers were not within the scope of NSA. (W.H.K.)

*For abstracts of individual papers see: 29180–29185, 29512, 29647, and 29648.*

## Protective Substances

*Refer also to abstracts 28774, 29342, 29380, 29382, 29384, 29427, 29455, 29597, 29714, 29753, 29773, 29781, and 29902.*

**29563** (AD–675514) AGE AT X-IRRADIATION AND ACUTE RADIATION MORTALITY IN THE ADULT MALE RAT. Jones, Dave C.; Osborn, Garold K.; Kimeldorf, Donald J. (Naval Radiological Defense Lab., San Francisco, Calif.). Aug. 5, 1968. 24p. (USNRDL-TR-68-87). CFSTI.

Male rats received whole body single doses of 250 kVp x rays at various ages ranging from young adulthood to old age. From probit analysis, the LD50/30 values for groups exposed at 3 or 7 months of age were 851 and 900 R, respectively. After adjustment for the natural morality rate, LD50/30 values for groups exposed at 17, 21, or 24 months of age were 776, 806, and 747 R, respectively. The mean survival time at the LD50/30 for the group exposed at 3 months of age exceeded those for groups irradiated at older ages. The slope of the dose versus survival curve for the youngest group was almost twice that for groups exposed at older ages, reflecting increasing variability of the population with increasing age. These findings indicate that age at exposure is an important variable to be considered in establishing parameters of acute radiation mortality in adult animals. (auth) (USGRDR)

**29564** (AD–678530) MECHANISMS OF PROTECTION AGAINST GASTROINTESTINAL AND HEMATOPOIETIC RADIATION LETHALITY BY PARABIOSIS. Carroll, Harold W.; Kimeldorf, Donald J. (Naval Radiological Defense Lab., San Francisco, Calif.). Nov. 26, 1968. 23p. (USNRDL-TR-68-110). CFSTI.

The mechanisms for protection through parabiosis against both the acute intestinal and hematopoietic radiation death were investigated in two separate experiments. The length of time after irradiation that the parabiosis must remain intact for protection to occur was investigated in the first experiment. The data showed that if surgical separation was delayed to 48 hours postexposure, protection against three to five day death occurred and if delayed to 96 hours, protection against 30-day lethality also occurred. The second experiment was designed to test the quantity of whole-body radiation that one member of a parabiotic pair could receive (dose range 250 to 1000 R) and still provide protection to the simultaneously irradiated partner (1500 R). The results of this experiment showed that over the dose range tested, none of the doses altered the animal's capacity to protect an irradiated partner (1500 R) against the three to five day death. Substantial 30-day survival also occurred with all the test doses employed except at the highest exposure level (1000 R). The findings are consistent with the hypothesis that protection through parabiosis against three to five day death is one of electrolyte and fluid maintenance and protection against 30-day mortality is through transfer in peripheral blood of stem cells capable of repopulation of bone marrow. (auth) (USGRDR)

**29565** (CEA-R-3669) RADIOPROTECTIVE PROPERTIES OF SOME HETEROCYCLIC NITROGENOUS COMPOUNDS AGAINST CHANGES IN HEMOGLOBIN CONCENTRATION AND HEMATOCRIT VALUE IN X-IRRADIATED MICE. Rousdhy, Hamid; Pierotti, Theodore; Polverelli, Michel (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jan. 1969. 24p. (In French). Dep.

Radioprotectives properties of imidazole and benzimidazole have been proved in previous works. The radioprotective action of these compounds in comparison with cysteamine upon the hematopoietic system after lethal x irradiation is demonstrated Results showed no drastic variations of hematologic constants (hemoglobin concentration and hematocrit value) after intraperitoneal injection of radioprotective compounds apart from certain apparent reactions with the heterocyclic compounds. It was also found that benzimidazole had a better radioprotective action. Twenty five days after irradiation, hemoglobin concentration and hematocrit of radioprotected mice return to normal values. (C.O.)

**29566** (CEA-R-3688) RADIOPROTECTIVE PROPERTIES OF SOME HETEROCYCLIC NITROGENOUS COMPOUNDS AGAINST SPECTRAL MODIFICATIONS IN HEMOGLOBIN OF X-IRRADIATED MICE. Roushdy, Hamid; Pierotti, Theodore; Polverelli, Michel (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jan. 1969. 23p. (In French). Dep.

Imidazole and benzimidazole are known for their radioprotective action. In this work, authors have studied the radioprotective action of these compounds on visible and ultra-violet hemoglobin absorption spectra obtained from mice after in vivo x irradiation. Results compared to those obtained with cysteamine show: a possible pharmacological action of the heterocyclic nitrogenous compounds on the $\alpha$ and $\beta$ bands (540 and 580 m$\mu$); a significant variation of the ratio of the optical densities (580/540) after irradiation with hemoglobin of non protected and radioprotected mice. However, following a real drop of absorption maxima, the twenty-fifth day after irradiation, normal optical densities of each band were found again. A physico-chemical study would be necessary to understand the hemoglobin transformation after irradiation and its possible radioprotection. (auth)

**29567** (CEA-R-3689) RADIO-SENSITIZATION OF ANIMALS BY BISMUTH. Pierotti, Theodore; Verain, Andre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar. 1969. 20p. (In French). Dep.

Digestive absorption of bismuth by animals leads to radiosensitization. This effect is very marked when the x rays used are centered on the absorption line of bismuth. This work has involved the use of more than 2,000 C3H/JAX mice, and has shown that a maximum lethal effect, with respect to the standard, occurs for bismuth sub-nitrate doses of the order of 3 g/kg and for exposures of 700 R. For stronger or weaker doses, the sensitization effect is less marked. (auth)

**29568** (COO–1024-33) A COMPARISON OF THE CYTOLOGICAL EFFECTS PRODUCED BY IONIZING RADIATIONS OF DIFFERENT LET. Technical Progress Report. (Iowa Univ., Iowa City. Radiation Research Lab.). Mar. 1969. Contract AT(11-1)-1024. 11p. Dep. CFSTI.

Summaries are presented of investigations concerned with the cataractogenic effects of x rays and fast neutrons on the cell population of the lens epithelium of rats and factors that could modify these effects. Results of studies on the effects of fractionated x radiation and fast neutron doses revealed that there was essentially no recovery of the lens during the intervals between radiation doses. Studies on the response of x-irradiated or fast neutron-irradiated lens epithelia to wounding in relation to abnormal mitotic phases indicated no significant difference in percentage of abnormalities. An increased cataractogenic effectiveness of both single and fractionated x and fast neutron doses were observed when mice were irradiated in $O_2$ at 2.5 atmospheres of pressure. The cataractogenic effects of x radiation were mitigated by DMSO; it did not provide complete prevention. (C.O.)

**29569** (COO–1223-14) HYPOXIA AND PARA-AMINOPROPIOPHENONE AS RADIOPROTECTIVE AGENTS. Progress Report, August 1, 1967–September 30, 1968. Bonner, John F. Jr. (Indiana Univ., Indianapolis. Dept. of Biochemistry). Contract AT(11-1)-1223. 18p. Dep. CFSTI.

The reaction mechanisms involved in the radioprotective effects of hypoxia and p-aminoprophiophenone (PAPP) on animals were investigated. The metabolism of p-aminoprophiophenone in mice was studied, and a metabolic role for the radioprotective action of PAPP was suggested. The effects of 15 radioprotective compounds on the convulsive and lethal effects of continuous exposure to high-pressure oxygen were studied in mice. Cysteamine and serotonin were the most effective compounds of those tested for delaying the first convulsion and time of death. Thirty-four radioprotective compounds were tested for their effectiveness in protecting lysozyme in solutions against $\gamma$-radioinduced inactivation. (C.H.)

**29570** (COO–1391-17) ISOLATION OF A FACTOR PREVENTING X-RAY INDUCED LEUKEMIA. Progress Report, January 1, 1968–January 31, 1969. Hodes, M. E. (Indiana Univ., Indianapolis. Medical Center). Feb. 14, 1969. Contract AT(11-1)-1391. 32p. Dep. CFSTI.

Results of fractionation and leukemia-prevention studies begun and partially completed on the proteins of Cohn Fractions III and IV obtained from sheep serum, and on studies with other proteins of ovine origin are presented. Each of these proteins was tested for its ability to prevent lymphosarcoma (leukemia) in x-irradiated C57B1/6 mice. Development of a shorter assay for RLP (radiation-leukemia protection factor) was also discussed. Spleen and serum fractions were assayed for $\alpha_2$-macroglobulin (as the trypsin-esterase complex resistant to inhibition by soybean trypsin inhibitor). A good correlation between RLP activity and $\alpha_2$M content was found for spleen but not for serum. Changes in

enzyme levels after x-irradiation and treatment with RLP were studied. DNA and RNA polymerase were added to the list of enzymes investigated. RNA polymerase behaved in the manner of enzymes previously studied. By contrast, DNA polymerase decreased after irradiation and increased again when RLP was injected. Changes in the total peripheral leukocyte count and in thymus weight followed x-irradiation and were prevented in part by RLP. Finally, studies on changes in the $\alpha_2$-M of serum after irradiation of the mouse and treatment with RLP were initiated. There were significant differences between irradiated and irradiated plus RLP treated mice. Several protein fractions were compared in both the leukemia protection test and one or more of the shorter assays. (C.O.)

**29571** (JPRS-47370) ANTIMETABOLITES IN THE TREATMENT AND PROPHYLAXIS OF RADIATION SICKNESS. Danysz, A.; Kocmierska-Grodzka, D.; (and others). Translated from Med. Radiol., 13: No. 12, 3-8(Dec. 1968). 11p. CFSTI.

The radioprotective effects achieved by normalizing the post-radiation disturbances, i.e., by suppressing the catabolic processes through the use of anticatabolic agents and by intensifying the anabolic processes through the use of appropriate drugs were investigated. Methandrostenolone (Dianabol) injected into the stomach or subcutaneously in an oil solution in doses ranging from 0.2 to 2 mg/kg a day for 10 to 20 days prior to x irradiation produced a distinct antiradiation effect in mice and rats (males and females). The 1 mg/kg dose injected into the stomach proved to be the most effective. The dose reduction factor increased the longer the drug was administered before irradiation. After 20 days of use, it was 1.3 and 1.6 in male rats and 1.6 in the females. Other radioprotective effects observed and the mechanisms of action are discussed at length. The intensifying effects of insulin, $\gamma$-hydroxybutyric acid, and serotonin plus antifibrinolytics on the radioprotective effects of methandrostenolone were also studied. It was concluded that the protective effect was probably due to tissue hypoxia and weakening of post-radiation changes in the synthesis of proteins and nucleic acids. (C.O.)

**29572** (NYO-2192-12) AN INVESTIGATION INTO THE PHARMACOLOGICAL PROPERTIES OF ANTI-IRRADIATION DRUGS. Progress Report. DiStefano, Victor F. (Rochester Univ., N. Y. School of Medicine and Dentistry). Feb. 19, 1969. Contract AT-(30-1)-2192. 10p. Dep. CFSTI.

The thiol derivatives, sodium hydrogen s-(2-aminoethyl) phosphorothionate (AEP) and 3-(2-mercaptoethylamino) propionamide p-toulene sulfonate (METS), which had been found to have a protective effect against lethal x irradiation in mice, were tested for their pharmacological properties in cats. Data are presented on the effects of the drugs on blood pressure, respiration, contractions of nictitating membrane and intestine, and electrocardiograms. Prior to drug administration, the animals were challenged with norepinephrine and acetylcholine to determine whether AEP and METS potentiate or depress adrenergic or cholinergic systems. Mechanisms involved in the depletion of cardiac catecholamines by mercaptoethylene guanidine (MEG) were also studied. (C.H.)

**29573** (UCRL-18347, pp 71-81) ERYTHROPOIETIC RESPONSE IN DOGS GIVEN SUBLETHAL WHOLE BODY PROTON IRRADIATION FOLLOWED BY HYPOXIC HYPOXIA. Aceto, Henry Jr.; Springsteen, Robert W.; Gee, W.; Winchell, H. Saul (California Univ., Berkeley).

Serial iron kinetics studies, using $^{59}Fe$ as a tracer, and $^{32}P$ determinations of total red cell volume were performed in three groups of beagle dogs exposed to hypoxia ($pO_2$ = 72 mm Hg), sublethal whole-body proton irradiation (200 rads MTD), and a combination of these two stresses, respectively. Hypoxia alone resulted in an increase, within one day, in plasma iron turnover rate (PITR), an increase in fractional incorporation of $^{59}Fe$ in red cells, and a corresponding elevation in total red cell volume. Sublethal whole-body proton irradiation alone resulted in diminution within one day in PITR, and a corresponding marked depression of fractional incorporation of $^{59}Fe$ in red cells. Dogs receiving a combination of whole-body proton irradiation followed by hypoxic hypoxia demonstrated an initial increase in PITR for the first 7 days approximating the response seen with hypoxia alone. At 14 days the PITR and the fractional $^{59}Fe$ incorporation into red cells rapidly decreased, approaching, but not reaching, that seen in the dogs receiving radiation alone. Thereafter, the increase in the PITR in these dogs was greater than that seen following radiation alone and by 29 days again approximated that seen in dogs subjected to hypoxia alone. At all times total red cell volume in dogs subjected to combined whole-body radiation and hypoxia was maintained at a level intermediate between that seen in dogs subjected to whole body radiation or hypoxia alone. It was concluded that following sublethal whole-body proton irradiation, cells responsible for synthesis of hemoglobin are capable of normal or increased rates of hemoglobin synthesis in response to hypoxic stimulation despite severe radiation damage. (C.H.)

**29574** STUDIES ON THE CURATIVE TREATMENT OF THE RAT SUBMITTED TO A LETHAL DOSE OF X RAYS. Loiseleur, J.; Catinot, L.; De Vomecourt, A. (Institut Pasteur, Paris). Ann. Inst. Pasteur, 116: 103-10(Jan. 1969). (In French).

The protective effect of certain factors in the serum of sublethally irradiated animals on lethally irradiated animals was investigated. Rats receiving 1000 R whole-body x irradiation showed a rapid fall of body weight (30 to 40% below normal three to five days postirradiation). Diarrhea, as a result of injury of intestinal epithelium, occurred in the same period. Lethally irradiated rats were injected with the serum of rabbits given whole-body doses of 350 R followed by 50 R six days later. Serum obtained on the eighth day was injected in 3 ml doses immediately after the rats received 1000 R and the injections were repeated daily up to the ninth day. Two of the four rats survived for more than 30 days, and the two others for 14 and 29 days respectively. Diarrhea occurred in only half of the animals. In another experiment, serum from one rabbit receiving 250 R was injected into a second rabbit irradiated with 250 R. Serum from the second rabbit was injected into 1000 R irradiated rats for three days. One rat survived more than 30 days. In other experiments the maximum effectiveness of donor rabbit blood was found at two days postirradiation on the basis of diarrhea suppression. It was concluded that serum from sublethally irradiated animals can reduce the incidence of diarrhea by $\frac{1}{2}$ and increase 30-day survival rate by $\frac{1}{4}$ in lethally irradiated recipients. (BBB)

**29575** EXPERIMENTAL STUDY ON RADIOPROTECTIVE ACTION OF GLYCOSIDIC DERIVATIVES OF p-AMINOACETOPHENONE UNDER CONDITIONS OF DEEP IRRADIATION. Putowa, Anna; Sykulski, Jerzy (Pomeranian Medical Academy, Szczecin, Poland). Acta Pol. Pharm., 24: 541-6(1967).

The effects of p-aminoacetophenone, p-aminoacetophenone glucoside ($AmAc_1$) and p-aminoacetophenone arabinoside ($AmAc_5$) upon the time of survival, the body weight, and post-irradiation leucopenia in rats irradiated with 600 R of x rays were studied. Aqueous suspensions of the substances were intraperitoneally administered. The animals were given the doses of $\frac{1}{3}$ $LD_{50}$ 6 hr before irradiation, or 200 mg/Kg of body wt on the day of irradiation and 50 mg/Kg daily for 10 days consecutively after the irradiation. The substances had only a weak radioprotective action when administered intraperitoneally in single doses before irradiation. However, repeated administration of $AmAc_1$ and $AmAc_5$ after irradiation increased the survival of the animals. The peripheral leucocyte counts in nonirradiated animals were unaffected by the doses of the compounds tested. (BBB)

**29576** N-SUBSTITUTED DERIVATIVES OF 2-AMINOETHANETHIOL AND 2-HYDRAZINOETHANETHIOL. Westland, Roger D.; Holmes, Joyce L.; Green, Billie; Dice, John R. (Parke, Davis and Co., Ann Arbor, Mich.). J. Med. Chem., 11: 824-9(July 1968).

A study was made of the effect on radioprotective action of many variations in nitrogen substitution of 2-aminoethanethiol. Direct alkylation of primary amines with ethylene sulfide (generated in situ) provided many of the analogs. Other derivatives were obtained by debenzylation of N-[2-(benzylthio)ethyl]alkylamines. These benzylthio ethers were prepared by reduction ($LiAlH_4$) of amides obtained from either (benzylthio)-acetyl chloride or 2-(benzylthio)ethylamine, and alkylation of 2,2,2-trifluoracetamides with benzyl 2-chlorethyl sulfide. Alkylation of 1,2-bis(trifluoracetyl)-1-alkylhydrazines using benzyl 2-chloroethyl sulfide afforded substituted 2-hydrazinoethanethiols. None of the compounds was superior to 2-aminoethanethiol in protecting against radiation damage as tested in mice. (BBB)

**29577** N-SUBSTITUTED S-2-AMINOETHYL THIOSULFATES AS ANTIRADIATION AGENTS. Westland, Roger D.; Holmes, Joyce L.; Mouk, Mary Lou; Marsh, Douglas D.; Cooley, Richard A. Jr.; Dice, John R. (Parke, Davis and Co., Ann Arbor, Mich.). J. Med. Chem., 11: 1190-201(Nov. 1968).

N-substituted derivatives of S-2-aminoethyl thiosulfate were prepared for testing as radioprotective agents. Cycloalkylalkyl, cycloalkylalkyloxyalkyl, cycloalkyloxyalkyl, aralkyl, and aryloxyalkyl groups were induced as substituents on nitrogen. The length of the linear alkyl group separating the cyclic portion from the amine was varied from zero to nine carbon atoms. Branched chains also were used as insulating groups. Antiradiation activity in mice was found throughout the series, and several compounds can be administered to obtain a good radioprotective effect at $\frac{1}{10}$ to $\frac{1}{15}$ of toxic ($LD_{50}$) doses. Activity by oral administration also was obtained for some compounds. A table shows the $LD_{50}$ toxicity doses and the 30-day survival of mice exposed to x rays or $^{60}Co$

γ rays. Among cycloalkylalkyl derivatives, highly active compounds were obtained by incorporating cyclobutyl, cyclopentyl, and cyclohexyl groups. The best activity in this series was obtained when the alkyl group insulating the ring from the amino group was butyl, pentyl, or hexyl. Branching of the insulating group in this series, rather than decreasing biological effectiveness, in some cases actually increased the therapeutic index. Substitution of the cyclohexane ring resulted in highly active compounds, although a 3-cyclohexenyl derivative was one of the most effective agents. (BBB)

**29578** DERMATOLOGIC INDICATIONS FOR IONIZING TREATMENT. IONIZING TREATMENT OF EPITHELIOMA AND MALIGNANT MELANOMA USING NEW RADIOSENSITIVE TECHNIQUES. Scolari, E. G. (Univ., Florence). pp 1078-81 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In French).

See CONF-670719-(Vol.2).

Studies made on the radiosensitization of tumor cells using sodium cyclohexylsuccinate and oxygen under pressure are briefly reviewed. The possible mechanism of the oxygen effect is discussed. Studies were made on the combined treatment with sodium cyclohexylsuccinate and oxygen under pressure. No statistical results are available as yet, but the combined technique appears promising. (J.S.R.)

**29579** TREATMENT OF SKIN TUMOURS WITH RADIUM AND HYPERBARIC OXYGEN. Vallecchi, C.; Mantellassi, G. (Univ., Florence). pp 1087-8 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.

See CONF-670719-(Vol.2).

Seventy-five malignancies were treated with the tumor dose given in a continual or fractionated method. The irradiation was administered by application of a radium mold to the region being treated. The radium preparation, their technical characteristics and the calculations of the dose corresponded to classical radium therapy. Hyperbaric oxygen pressure was applied daily or every other day in a variable number of sittings where the patient received pure oxygen for 2 hr at 3 atmospheres. An increased rate of favorable results was observed in respect to analogous situations where ordinary radiological measures were used alone. Results of therapy on the different types of malignancies are discussed. The advantages of the method are listed. (C.O.)

**29580** STUDIES ON EXPERIMENTAL PHOTOSENSITIZATION WITH SULFANILAMIDE AND PHENOTHIAZINE. Schwarz, K.; Rothenstein, J.; Schwarz-Speck, M. (Dermatologische Univ., Zurich). pp 1106-7 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In German).

See CONF-670719-(Vol.2).

Animal studies and the clinical data on light-dependent dermatoses from sulfonamide and phenothiazine showed that significant differences exist between the two groups. Sulfanilamide is rapidly converted into a blue material which is unaffected by uv radiation. Chlorpromazine, on the contrary, is changed slowly by several intermediary products. Albino guinea pigs were exposed to uv radiation, with one set of guinea pigs coated with chlorpromazine before irradiation and the other after irradiation. The results showed that the uv light is essential for the sensitization, but that it makes no difference whether the irradiation occurs before or after the application. (J.S.R.)

**29581** THE MECHANISM OF STRUCTURAL PROTECTION OF DNP BY CERTAIN PROTECTORS. Andrianov, V. T.; Pisarevskii, A. N.; Spitkovskii, D. M.; Krot, V. I. (Belorussian State Univ., Minsk). Radiobiologiya, 9: 302-4(1969). (In Russian).

The influence of classical protectors: β-mercaptopropylamine, propyl gallate, S-β-aminoethylisothiuronium bromide, 5-methoxytryptamine, 5-chlorotryptamine, 5-hydroxytryptamine, and gallic acid on the structural transitions of DNA in DNP at the physiological ionic strength of the medium was investigated in the work. 5-Hydroxytryptamine and gallic acid induce a strong flow of the DNP fibers. The remaining protectors displace the helix-ball transition into the low-temperature region, just like typical cross-linking agents. On the basis of the data obtained the authors proposed a new type of protection—the structural principle. (auth)

**29582** STATE OF THE VESSELS OF THE BRAIN UNDER THE ACTION OF RADIOPROTECTORS. Semenov, L. F.; Altukhova, L. N.; Dobrovol'skii, N. M. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Radiobiologiya, 9: 242-5(1969). (In Russian).

The influence of radioprotective amines and thiols on the vessels of the brain, the vascular permeability, and on the sorption properties of the brain proteins was investigated according to the method of accumulation of neutral red in the brain tissue per unit time after intravital administration. It was established that amines increase the content of the dye in the brain. This is evidence of a dilation of the brain vessels, an increase in the permeability of the hematoencephalic barrier, and an increase in the blood supply of the brain. Thiol radioprotectors do not influence the binding of dyes. Radioprotective amines and thiols, when introduced into the organism, do not influence the sorption properties of the brain proteins in the case of in vitro staining of the brain tissue. (auth)

**29583** INFLUENCE OF RADIOPROTECTORS ON THE STATE OF THE INTESTINAL BLOOD VESSELS (ACCORDING TO THE DATA OF VITAL STAINING). Altukhova, L. N. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Radiobiologiya, 9: 305-7(1969). (In Russian).

A study of the influence of radioprotective sulfur-containing substances and amino compounds on the state of the intestinal blood vessels indicated that these protectors did not influence its blood supply in various modes of introduction of the dye. The weakening of the ability for staining of the intestines observed under the action of indolylalkylamines and adrenalin is not associated with the influence of the amines on its vessels, but depends on subcutaneous deposition of the dye. (auth)

**29584** RADIOPROTECTIVE PROPERTIES OF SOME HETEROCYCLIC NITROGENOUS COMPOUNDS AGAINST X-RADIATION INJURY TO SERUM PROTEINS IN MICE. Roushdy, H.; Pierotti, T.; Polverelli, M. (Centre d'Etudes Nucleaires, Grenoble, France). Z. Naturforsch., 24b: 622-30(May 1969).

The results of this study suggest the following: The concentration of total serum proteins in mice is changed very little under the various treatments, while protein fractions showed significant alterations. The concentrations of various serum proteins remained almost constant under normal conditions. Intraperitoneal administration of imidazole or benzimidazole at the mentioned doses induced rapid quantitative changes in the serum that were recovered about 3 days after injection. Whole-body x irradiation at 750 R created slow but progressive and persisting serious changes in concentration of serum protein fractions that ended in death of animals 8 to 10 days after irradiation. Whole-body x irradiation of imidazole or benzimidazole protected animals resulted in quantitative rapid changes in concentration of serum protein fractions for about four days. Thereafter a slow but steady restoration began. The concentration approached the normal levels towards the 10th day after irradiation. Imidazole and benzimidalose proved to be good radioprotectants against the effects of x radiation on serum protein fractions. Benzimidazole seemed to surpass imidazole. (auth)

**29585** TRANSPLANTATION OF BONE MARROW FROM SEVERAL DONORS TO DOGS IRRADIATED IN A DOSE OF 1000 R. Novikova, M. N.; Chertkov, I. L. (Central Inst. of Hematology and Blood Transfusion, Moscow). Probl. Gematol. Pereliv. Krovi, 14: No. 5, 24-8(May 1969). (In Russian).

Bone marrow obtained from 5 to 8 unrelated donor dogs was injected to irradiated dogs (a dose of 1,000 R). In 8 of 9 such experiments there occurred only lymphoid differentiation of transplanted elements as in administration of bone marrow from only one donor. Normal hemopoiesis was observed in one of the transplants. Consequently, the presence of acute immune reaction of the type, transplant against the host, did not prevent normal histogenesis of hemopoietic tissue which was the most affiliated to the recipient. Only one of 56 donor-recipient combinations proved to be adequate. Possibilities of clinical use of bone marrow mixture from many donors are discussed. (auth)

**29586** HYDROXYUREA: A RADIOSENSITIZER IN THE TREATMENT OF NEOPLASMS OF THE HEAD AND NECK. Richards, George J. Jr.; Chambers, Robert G. (Greater Baltimore Medical Center). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 555-65(Mar. 1969).

Forty patients were treated in a double blind study utilizing hydroxyurea. Those treated with hydroxyurea, irradiation and surgery achieved complete eradication of tumor. The most notable contribution of hydroxyurea appeared to be the extensive necrosis, radiation effect, and destruction beyond any recognition of tumor in lymph nodes. Forty-five cases, previous failures to other modalities, were retreated with hydroxyurea and irradiation with local regression of tumor in all cases. (auth)

**29587** EFFECT OF AGE AND AET ON LIFE SPAN OF IRRADIATED MALE AND FEMALE RATS. Leonard, Alain; Maisin, Jean Rene; Deknudt, Ghislain (Centre d'Etude de l'En-

ergie Nucleaire, Mol, Belgium). Strahlentherapie, 137: 92-100 (Jan. 1969).

The life shortening effect of 300 R of x-irradiation has been studied in 8, 17, 60, or 200 days old male and female rats given or not, an intraperitoneal injection of AET before exposure. In the unprotected groups the females appeared more sensitive to the longterm effects of radiation than did the males since they show greater reduction in their life expectancy. The data for rats of both sexes indicate reduced life shortening with increasing age at exposure. Intraperitoneal injection of AET at the dose of 200 mg/kg of weight was found to induce some life shortening in the non-irradiated animals. The reduction of life expectancy was highest for the animals injected at 17 days of age. In most of the groups the life shortening effect of x-irradiation is increased by injection of AET prior to exposure with a maximal shortening of life span in both male and female groups given AET prior to irradiation at 17 days of age. (auth)

**29588** FACTORS INFLUENCING HEMATOPOIETIC SPLEEN COLONY FORMATION IN IRRADIATED MICE. VI. THE DIFFERENT EFFECTS OF FOREIGN PLASMA, ENDOTOXIN, AND BLEEDING ON COLONY-FORMING CELL KINETICS. Boggs, D. R.; Marsh, J. C.; Chervenick, P. A.; Cartwright, G. E.; Wintrobe, M. M. (Univ. of Utah, Salt Lake City). Radiat. Res., 35: 68-77(1968).

An increase in the number of endogenous hematopoietic spleen colonies present on the spleen of mice 10 days after irradiation was induced by injection of foreign plasma or endotoxin or by bleeding before irradiation. This study was initiated to determine if these factors influence the colony-forming cell compartment in a similar or dissimilar fashion. A single injection of endotoxin was as effective as repeated doses of endotoxin, whereas repeated plasma injections or repeated phlebotomies were more effective than when given as a single stimulus. An injection of endotoxin given 1 hr after irradiation increased the number of endogenous spleen colonies, whereas plasma injection and bleeding had no effect when given at this time. In unirradiated mice, a single injection of plasma had no effect on spleen weight or spleen iron uptake, but bleeding increased iron uptake, while endotoxin increased spleen weight. (auth)

**29589** RADIATION PROTECTION STUDIES ON RATS TREATED WITH ESSENTIAL PHOSPHOLIPIDS OF THE EPL SUBSTANCE AFTER 750, 850, AND 1200 R X RADIATION. Szirmai, E. (Univ., Stuttgart. Institution of Nuclear Engineers, London); Hajdukovic, S.; Haley, T. J.; Jovanovic, M.; Radivojevic, D. Fortschr. Geb. Roentgenstr. Nuklearmed., 109: 786-93(Dec. 1968). (In German).

Rats were used to assess the radioprotective effects of the commercial preparation Essentiale (Nattermann-303 capsules). This preparation contains essential phospholipids of natural origin with 70% linolinic acid. Survival was studied in rats given Essentiale orally prior to and following administration of 750 or 850 R doses of x radiation. Blood sugar was measured in rats exposed to 1200 R x radiation or to Essentiale. (C.H.)

## *Radiation Sickness and Injuries*

*Refer also to abstracts 29683, 29795, and 29821.*

**29590** SURGERY FOR RADIATION-DAMAGED BOWEL. Seybold, William D.; Chambers, Mark D. (St. Luke's Episcopal Hospital, Houston, Tex.). Postgrad. Med., 44: 98-107(Oct. 1968).

The late complications of radiation exposure to the intestines reported are based on experience with six patients following radiotherapy. Diagnosis and surgical management of the complications are emphasized. (BBB) (TSS)

**29591** THERAPEUTIC USE OF BONE-MARROW TRANSPLANTATION. Andrews, Gould A. (Oak Ridge Associated Universities, Inc., Tenn.). pp 423-32 of Proceedings of the International Conference on Leukemia–Lymphoma, Ann Arbor, Michigan, October 9–13, 1967. Zarafonetis, Chris J. D. (ed.). Philadelphia, Lea and Febiger, 1968.

See CONF-671073.

Marrow transplantation could become an important method of therapy for example, in patients exposed to radiation, but only limited benefits have actually been obtained in patients. Transplants between identical twins are rarely useful clinically for the obvious reason that such a twin is usually not existent, and autografts so far have not been shown to be more than moderately effective as an adjunct to cancer therapy. Allogeneic graft attempts have usually failed to take or have severe immunologic complications. In a few instances, however, there has been unequivocal success without undue immunologic difficulties, and these give encouragement to further attempts. (C.O.)

**29592** TRANSPLANTATION OF FRESH AND PRESERVED AUTOLOGOUS BONE MARROW IN SUPERLETHALLY IRRADIATED DOGS. Novikova, M. N.; Fedotenkov, A. G.; Chertokov, I. L. (Ministry of Health, Moscow). Probl. Gematol. Pereliv. Krovi, No. 2, 16-21(1968). (In Russian).

The therapeutic effectiveness of transplanting preserved autologous bone marrow with that of freshly prepared autologous bone marrow was compared. The method of preservation, described previously (A. G. Fedotenkov, et al.), was freezing to −196°C with glycerine or dimethylsulfoxide as enclosing media. Experiments with fresh autologous bone marrow were conducted with seven dogs, five of which were irradiated with a dose of 1,000 R, one with a dose of 1,200 R and one with a dose of 1,500 R. Preserved autologous bone marrow was transplanted in eight dogs irradiated with a dose of 1,000 R. The course of radiation sickness followed the morphological composition of the peripheral blood and bone marrow punctuates was determined and a general calculation of nucleated cells per cubic millimeter of bone marrow was made. Survival was practically identical for the two groups; five out of seven dogs receiving fresh bone marrow survived, while seven out of eight dogs receiving preserved bone marrow survived. Recovery of hemopoiesis began earlier in dogs receiving fresh bone marrow, but by the twenty-eighth or thirtieth day certain hemopoietic indices were approximately the same for the two groups. Dogs receiving preserved bone marrow had slower recovery of all indices of the peripheral blood (except for the lymphocytes) than dogs receiving fresh bone marrow. Suppression of thrombocytopoiesis was more profound and prolonged in dogs receiving preserved bone marrow. In both groups the number of thrombocytes returned to the initial values after 2.5 months. Reduction in the indices of the red blood cells was also more pronounced and prolonged in dogs receiving preserved bone marrow. In general regeneration of hematopoiesis in dogs receiving preserved bone marrow lagged behind that of dogs receiving fresh bone marrow by 10 to 15 days. No confident explanation for this difference was given. No difference was noted between the dogs receiving preserved bone marrow that would indicate that the storage time played any role. Bone marrow stored one year and seven months was as effective as bone marrow stored for two to three weeks. (JPRS)

**29593** TRAUMA TO THE RECTUM. Claydon, Charles; Martin, J. D. Jr. (Emory Univ., Atlanta). Amer. Surg., 34: 317-20(May 1968).

Diagnosis and treatment of 37 cases of rectal injury, including 5 with radioinduced lesions, are reported. In the treatment of these injuries, the basic surgical principles of adequate wound care and drainage are most important. If there is any doubt as to the seriousness of the injury, laparotomy should be performed. The mortality rate associated with rectal injuries appears to be low, except when associated with perforation of bowel following barium enema and associated with multiple organ involvement. Injuries to the rectum from radiation were related to radiation proctitis and resulting hemorrhage. Five patients were admitted to the emergency ward with rectal hemorrhage; only one required sigmoid colostomy. After 6 yr no further bleeding in this patient has been reported. The other four were treated with transfusion alone, usually one or two units. The underlying lesion in all patients was carcinoma of the cervix that had been treated by internal and external radiation. (BBB)

**29594** NEW DATA ON THE TREATMENT OF OSTEORADIONECROSIS. Heiss, J.; Grasser, H. H. (Univ., Munich). Deut. Zahnaerztl. Z., 22: 265-70(Feb. 1967). (In German).

Recent developments in treatment of osteoradionecrosis are outlined and discussed. The treatment described emphasized reduction of the severe pain and vascular changes that accompany bone necrosis. Combination treatment with local anesthetics, such as Novocaine and Hostacaine, and vasoactive drugs, such as the pancreatic hormone, kallikrein (Padutin) or a β-pyridyl-carbinol derivative (Ronicol) produced good results without vasoastringent effects. Ronicol at first was administered intravenously at a rate of 450 to 600 mg over 2 or 3 hr daily for the first week, then at a rate of 500 to 2000 mg/day during the second week, decreasing gradually to 300 to 450 mg/day for longer term therapy. The Padutin dosages ranged from 40 biological units daily for the first 3 weeks downward to 20 or 30 units for the ensuing weeks of treatment. Iontophoresis procedures also were used for administration of the Ronicol. The treatments resulted in reduction of pain, heating and diminution of the mucosal defects, improved vascularization, granulation of the exposed bone areas, and the healing times of the osteoradionecroses were shortened. (BBB)

**29595** BIOCHEMISTRY, MORPHOLOGY, AND TRANSPLANTATION PROBLEMS OF RADIONECROSES. Kiricuta, I.; Popescu, V.; David, E.; Simu, G.; Mustea, I.; Gross, K.; Bojan, A. (Inst.

of Oncology, Cluj). Zentralbl. Chir., 92: 1147-52(1967). (In German).

Even in modern radiotherapy, not infrequently, destruction of the tumor is associated with severe dystrophy of the overlying skin and other tissues. Final treatment of these severe defects is wide surgical excision extending into normal tissue followed by suitable transplants. (H.B.G.)

**29596** SURGICAL THERAPY FOR RADIATION ENTERITIS. Mason, G. R.; Guernsey, J. M.; Hanks, G. E.; Nelsen, T. S. (Stanford Univ., Palo Alto, Calif.). Oncology, 22: 241-57(1968).

Thirty-five patients with enteric problems following abdominal radiation for neoplasms required one or more surgical procedures to alleviate their distress. These patients received surgical intervention for their symptoms from 1 month to 26 yr following therapy, most in 12 months or less. The mode of distribution was from 1 to 6 months (12 patients). There was no significant difference in patient age, cell type, stage of carcinoma, or radiation dose that could be related to the duration of time between radiation and surgery. Radiation-injured patients are often poor surgical risks. Chronic protein and blood loss, malnutrition, and anorexia are frequently associated with poor healing. Furthermore, the stenotic changes secondary to irradiation may be mistaken for recurrent carcinoma. The wide variety of presenting complaints and patient condition made it difficult to give any general principle as to type of procedure to be followed. Of 15 patients treated by small bowel resection, 4 patients died postoperatively. In 3 cases, the patients were severely debilitated, with marked body-weight loss. Three patients died of peritonitis, the fourth of cardiac arrest. If definitive therapy had not been delayed, the results might have been better. In the remainder of the group with small bowel abnormalities, there were 8 deaths at 2 months or longer postoperatively. Six of these deaths were from recurrent carcinoma. Small bowel resection, bypass, or lysis of adhesions thus was associated with an immediate operative mortality of 17%. Of 10 late deaths not associated with surgical procedures, 7 were related to recurrent carcinoma. It was concluded that resectional therapy is well tolerated when indicated for small bowel radiation damage, but surgery must be planned before the patient is physically deteriorated. Patients with previous intra-abdominal surgery present a higher risk of development of radiation enteritis and must be more carefully observed. (BBB)

**29597** A NEW SUBSTANCE IN THE TREATMENT OF RADIO-DERMATITIS, ESPECIALLY IN NEOPLASTIC PATIENTS, RADIOBIOLOGICAL, AND THERAPEUTIC FACTORS. Abad, R. Acta Oncol., 6: 28-66(Jan.-June 1967). (In Spanish).

The evolution of radiodermatitis is exhibited in a brief historical introduction of the problem, paralleling the discovery and use of x rays. The concept of radiodermatitis is judged then in its widest aspect, that is, considering x rays as a part of the radiations composing the electromagnetic spectrum; consequently with this concept, a comparative study is gradually made on the action of the different parts of the spectrum on the skin, basically with uv and light photons. This serves as a starting point for the study of radiodermatitis etiology. The radiobiological factors that influence its determination are shown and a study is made of the therapeutic elements that were utilized in the course of radiodermatites. Finally, the study of a new substance is introduced, within this affection's therapeutic arsenal, consisting of a lyophilised substance of a biological extract of Helix Hortensis which, in its topical application, fulfills, in the author's opinion, the two essential facets required: it is a protector when administered before the appearing of the radiodermatitis, thus preventing its appearance, and it is a restoring agent for lesions already caused. The study was directed only to solving the problem of radiodermatites produced by the therapeutic application of x rays in all types of patients, especially neoplastic, that constitutes a thorny problem in the performance of every radiotherapist. (auth)

**29598** SURVIVING LETHAL DOSE OF RADIATION. Med. World News, 9: 21-2(Apr. 5 1968).

Successful therapy for three victims of accidental exposure to whole-body x irradiation was described. Through a combination of bone marrow and platelet transplants, massive doses of antibiotics, and the total prophylaxis of patient and environment, all three men were saved. The success of the therapy proved that a community hospital can give effective treatment to radiation victims, and the increasing use of nuclear energy in industry, and the threat of nuclear warfare, makes this ability vital. (Arms Contr. Disarmament)

## Radiodiagnosis

*Refer also to abstracts 28756, 29152, 29166, 29181, 29341, 29496, 29505, 29522, 29556, 29668, 29834, 29863, and 29867.*

**29599** (ACRH-30, pp 28-37) RETENTION OF RADIOIRON IN THE LUNGS OF A WOMAN WITH IDIOPATHIC PULMONARY HEMOSIDEROSIS. DeGowin, R. L.; Sorensen, L. B.; Charleston, D. B.; Gottschalk, A.; Greenwald, J. H. (Argonne Cancer Research Hospital, Chicago, Ill.).

The amount of blood lost from the body in relation to that retained in the lungs of a menopausal woman with idiopathic pulmonary hemosiderosis was compared using linear profile scanning of $^{59}Fe$. The patient sustained a major pulmonary hemorrhage with a loss of more than one-third of her $^{59}Fe$-labeled erythrocytes from the peripheral blood. Nevertheless, visible hemoptysis was slight and only detected as blood-streaking of sputum that contained no measurable $^{59}Fe$-labeled erythrocytes. Although the iron-containing hemoglobin was retained in the body, it was not available for hemoglobin synthesis nor could it be readily mobilized with an iron-chelating agent. This pulmonary trapping of iron led to an iron-deficiency anemia; it was possible that the patient had one to ten times as much iron in her lungs as a normal person has in total-body iron stores. It was suggested that the linear profile scan demonstrating retention of $^{59}Fe$-labeled erythrocytes in the chest during intrapulmonary hemorrhage may prove specific for this disease. (C.O.)

**29600** (CONF-670649-34) MEDICAL APPLICATIONS OF RADIOISOTOPES IN DIAGNOSIS. Ramos Rodriguez, E. (Junta de Energia Nuclear, Madrid (Spain). Division de Medicina y Proteccion). [1967]. 15p. (In Spanish). Dep.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

A brief review is given of the development of the use of radioisotopes in medical diagnosis. The wide utilization of radioiodine, the gammagraphy of specific organs, and the introduction of short-lived isotopes are discussed, and examples of applications of each are cited. (J.S.R.)

**29601** (ORNL-IIC-4) $^{132}I$: REVIEW OF PROPERTIES, USES, AND METHODS OF PREPARATION. Gerrard, Martha; Pinajian, John J.; Baker, P. S. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 27p. Dep. CFSTI.

Literature on the properties, uses, and methods of preparing $^{132}I$ is reviewed. (~125 references) (auth)

**29602** (ORNL-tr-2132) CLINICAL EXPERIENCE WITH $^{115m}In$. Pal, I.; Gacs, J.; Toeorkoe, J.; Farkas, G. Translated for Oak Ridge National Lab., Tenn., from Strahlentherapie, Sonderbaende, 65: 63-9(1967). 6p. Dep. CFSTI.

In an attempt to reduce the radiation dose to the patient in scintigraphic visualization of liver and spleen, the 4.5 hour half-life radioisotope $^{115m}In$ was used. The $^{115m}In$ was separated daily from a generator of $^{115}Cd$. An isotonic and sterile solution of indium hydroxide or indium EDTA, carrier free and with stable indium as a carrier, was used for these experiments. Organ distribution, blood clearance, and renal clearance of the tracer were determined and radiation dose to the critical organs was calculated. Normal and abnormal scintigrams of liver and spleen carried out with $^{115m}In$ as a tracer are shown. (auth)

**29603** (ORO-3550-2) MYOCARDIAL SCANNING OF MONGREL PIGS USING LOW ENERGY NUCLIDE $^{131}Cs$ IN COMBINATION WITH SELECTIVE CORONARY ANGIOGRAPHY. Progress Report. Goodrich, Jack K. (Duke Univ., Durham, N. C. Medical Center). Feb. 29, 1968. Contract AT(40-1)-3550. 12p. (CONF-681033-2). Dep. CFSTI.

From Southeastern Chapter Society of Nuclear Medicine Meeting, Atlanta, Ga.

A series of 20 mongrel pigs was studied. Infarcts were produced with Ameroid constrictors and the pigs were scanned serially using $^{131}Cs$ for periods ranging up to 60 days. Scan results are presented in tabular form. In general, excellent correlation of scan interpretation and microscopic proof obtained at autopsy was observed. The infarctions of the anterior descending coronary artery were found to give the most positive evidence of disease by scanning. The right coronary and left circumflex lesions that lay at the periphery and posterior to the heart image as recorded by scans were considerably more difficult to see. A diagnostic aid, in the form of a transparent overlay was developed by x raying pigs of various sizes after exposing the aortic trunk, cannulating the coronary ostia, and injecting a barium-gelatin mixture. The overlay generated by tracing the arteries provided an outline of the heart with each coronary artery's distribution mapped out for each of the three scanning projections. (C.O.)

**29604** (TT-68-50001/1) POLISH REVIEW OF RADIOLOGY AND NUCLEAR MEDICINE. Translated reprint of Pol. Przegl. Radiol. Med. Nukl., 32: No. 1, 1-140(1968). 131p. CFSTI.

Separate abstracts were prepared for four articles in this

English translation which includes fifteen additional articles not within the scope of NSA. (H.L.W.)

*For abstracts of individual papers see: 29605–29608.*

**29605** (TT-68-50001/1, pp 46-61) ASSESSMENT OF OPERABILITY OF CARCINOMA OF THE LUNGS ON THE BASIS OF ANGIOPNEUMOGRAPHY AND PHLEBOGRAPHY OF THE SUPERIOR VENA CAVA. Pawlicka, Lilia. Translated from Pol. Przegl. Radiol. Med. Nukl., 32: No. 1, 1968.

Results of 50 angiopneumographs and 30 phlebographs of the superior vena cava and assessment of operability of carcinoma of the lungs on the basis of studies on the pulmonary blood vessels are discussed. Angiopneumography and phlebography of the superior vena cava are methods for studying the relations of the tumor and enlarged lymph nodes to the arterial and venous blood vessels. The purpose of this study is to evaluate angiography of the pulmonary artery and superior vena cava as methods for assessing operability. (auth)

**29606** (TT-68-50001/1, pp 97-9) TECHNIQUE OF THORACIC ROENTGENOGRAPHY IN EXPERIMENTAL RATS. Felczak, Jan. Translated from Pol. Przegl. Radiol. Med. Nukl., 32: No. 1, 1968.

A technique is described for making thoracic roentgenograms in experimental rats under general intraperitoneal anesthesia. Anesthesia was induced with amytal natrium in doses of 5 to 7 mg per 100 g of body weight. Ten to 15 min after injection experiments can be performed on the animals. (auth)

**29607** (TT-68-50001/1, pp 111-15) RADIOISOTOPE PLACENTOGRAPHY IN CENTRAL PLACENTA PRAEVIA. Jaroszewicz, Bohdan; Chomicki, Oskar. Translated from Pol. Przegl. Radiol. Med. Nukl., 32: No. 1, 1968.

With no clinical symptoms present, placenta previa was diagnosed in a multiparous woman by means of radioisotope placentography. Human serum albumin labeled with technetium-99m was used to localize the placenta. A case report is described and a figure is presented of the scintigram of central placenta previa. The diagnostic value of the radioisotope method is emphasized. (H.L.W.)

**29608** (TT-68-50001/1, pp 116-20) DEVICE FOR SEMI-AUTOMATIC REGISTRATION OF GAMMA RADIATION OF OSTEOTROPIC RADIOISOTOPES. Wojciechowski, Jerzy Marian. Translated from Pol. Przegl. Radiol. Med. Nukl., 32: No. 1, 1968.

Strontium-85 was injected intravenously into 30 patients suspected of having bone tumors. Radioactivity was measured by scintigraphy. Comparison of radioactivity of the healthy regions and regions where bone tumors were confirmed clinically, roentgenologically and at operation always showed greater activity over the bone tumors. A special table was constructed that was connected with the counting system and allowed semiautomatic registration of radioactivity of bones. Advantages of the device are pointed out. (H.L.W.)

**29609** (UCRL-18347, pp 10-22) WHOLE BODY SCANNING OF $^{59}$Fe IN EVALUATION OF BODY DISTRIBUTION OF ERYTHROPOIETIC MARROW, SPLENIC SEQUESTRATION OF RED CELLS AND HEPATIC DEPOSITION OF IRON. Ronai, Peter; Winchell, H. Saul; Anger, Hal O.; Lawrence, John H. (California Univ., Berkeley).

A simple, rapid imaging whole-body scanner used in conjunction with $^{59}$Fe was found valuable in visualizing marrow distribution, determining sites of red cell sequestration, and evaluating hepatic storage iron deposition. During the course of radioiron kinetics studies, whole-body scanning served as a useful check on the external monitoring activity curves, the accuracy of which is dependent on probe positioning and zero-time extrapolation. Such dependence occasionally results in ambiguities which can be resolved with the whole-body scan. (auth)

**29610** (UCRL-18347, pp 23-35) SKELETAL SURVEY OF METASTATIC TUMORS OF BONE USING $^{18}$F AND $^{85}$Sr WITH SCINTILLATION CAMERA AND WHOLE BODY SCANNER. Ronai, Peter; Winchell, H. Saul; Anger, Hal O. (California Univ., Berkeley).

A rapid radioisotopic skeletal survey method using $^{18}$F, the whole-body scanner, and the positron scintillation camera was evaluated for the early detection of metastatic tumors of bone. Results showed that a larger number of bone lesions can be detected with $^{18}$F than with either conventional skeletal x-ray surveys or $^{85}$Sr radioisotopic skeletal surveys. Fluorine-18 is taken up by both malignant and nonmalignant lesions of bone and the $^{18}$F skeletal survey primarily serves to indicate areas for careful radiological assessment and, if necessary, biopsy. Since $^{85}$Sr radioisotopic skeletal surveys have previously demonstrated the practicability of detecting metastatic bone lesions in the absence of radiologic changes, and since the present study strongly suggests the superiority of $^{18}$F over $^{85}$Sr in this regard, it was concluded that $^{18}$F skeletal survey using a whole-body scanner and positron camera is the most efficient means yet developed for detection of metastatic bone disease. (C.H.)

**29611** (UCRL-18347, pp 36-41) COMPUTER ANALYSIS OF BREATH $^{14}CO_2$ DATA. Winchell, H. Saul; Wiley, Kenneth G. (California Univ., Berkeley).

Subsequent to administration of many carbon-14-labeled materials, $^{14}CO_2$ is excreted in the breath. The shape of such breath $^{14}CO_2$ curves, as well as their amplitude, is related in part to the kinetics of the metabolic processes responsible for the eventual oxidation of the carbon atom in the position labeled with carbon-14. To provide an objective method for the analysis of breath $^{14}CO_2$ data, models were devised and the corresponding mathematical functions containing the parameters describing the measured rate of appearance of $^{14}CO_2$ in a form suitable for analysis by digital computers were derived. Previous experience with graphical analysis of breath $^{14}CO_2$ curves suggested that the late portion of the curve was well fitted by a series of exponential terms ($\Sigma_i A_i e^{-r_i t}$). One of these terms is identified with the turnover rate of $^{14}CO_2$ in the measuring device employed, whereas the remaining terms are identified with compartments involved in the metabolism of $^{14}$C-labeled material being studied. To correct for digression of the observed data from idealized compartmental behavior a function G(x) is defined. Examples are presented for G(x) = (delta function), $\Sigma_j A_j e^{-Y_j x}$, and $e^{kx}/(C + e^{kx})$. A method is presented for objectively evaluating the minimum length of time data must be collected to define the fitting parameters of a given model and for estimating the maximum number of compartments that can be defined by a set of $^{14}CO_2$ data. (C.H.)

**29612** THE DEMONSTRATION OF THOROTRAST INCORPORATION BY A WHOLE-BODY COUNTER. Birnmeyer, G. Arch. Klin. Exp. Ohren.-, Nasen- Kehlkopfheilk., 188: 547-52(1967). (In German).

Measurements of $ThO_2$ deposited in a patient by a multichannel whole-body counter are described and discussed. Difficulties that may be encountered in measurement of deposited $ThO_2$ are discussed. This is because of the difference between the amount of Th previously given and the Th in equilibrium with its decay products. After 15 yr this may amount to ~25%. The Th decay products may be redistributed by the blood and lymph or become encapsulated in fibrous tissue. Since 90% of the radiation from Th is from $\alpha$ particles that are very lethal to cells, it is possible that even though the theoretical latency times for tumor development could be exceeded, the cells may be killed before a tumor can develop. Latency time may be as long as 35 yr, so it may require another decade before adequate observations and data about the Th problem can be collected. Since Th and its decay products are excreted in only small amounts through the kidney and gut or through the lungs, and cannot be altered greatly, natural decay is the main route of activity decrease. (BBB)

**29613** RADIOGRAPHIC EXAMINATION OF NORMAL AND PATHOLOGIC CUTANEOUS AND SUBCUTANEOUS TISSUES. Gros, Ch.; Basset, A.; Schraub, S.; Maleville, J.; Grosshans, E.; Heid, E. (Service Central de Radiologie, Strasbourg. Clinique Dermatologique, Strasbourg). pp 1409-11 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In French).

See CONF-670719-(Vol.2).

Cutaneous and subcutaneous tissues were studied without preparation and after an opaque substance injection by following its resorption. The aspect of normal tissues is briefly described. The differences found in chronic edema are illustrated to show the possibilities of this technique using soft x rays at low voltage. (J.S.R.)

**29614** X-RAY DIAGNOSTICS OF INTESTINAL HELMINTHIASES OF POULTRY. Fried, K.; Jantosovic, J. (Univ. of Agriculture, Kosice, Czech.). Vet. Med. (Prague), 14: 147-54(Feb. 1969). (In Czech).

The possibility of an x-ray illustration of intestinal helminths, particularly of ascarides and cestodes, in poultry was investigated. When evaluating the x-ray findings it may be said in conclusion that also in chicken x-ray investigation it is possible to determine the presence of hook-worms and tapeworms mostly in the form of characteristic marks, but not their accurate number. The silhouette of tapeworms (because of their flat form) is less clear than is the case with hook-worms. The segmentations of these helminths can hardly be used as a distinctive character. (auth)

**29615** COMPARATIVE EVALUATION OF THE THORACIC IMPEDANCE AND ISOTOPE DILUTION METHODS FOR MEASURING CARDIAC OUTPUT. Judy, W. V.; Langley, F. M.; McCowen, K. D.; Stinnett, D. M.; Baker, L. E.; Johnson, P. C. (Baylor Univ., Houston, Tex.). Aerosp. Med., 40: 532-6(May 1969).

Values of cardiac output determined simultaneously in 17 normal adult male human subjects by means of thoracic impedance changes and radioisotope dilution are compared. The absolute values of cardiac output determined by the impedance technique were 1.31 times higher than those measured by radioisotope with the subjects at rest and after moderate exercise. Even though the absolute values as found by the two methods were not the same, the changes in magnitude were comparable. (auth)

**29616** MEASUREMENTS OF RENAL GLOMERULAR FILTRATION RATE USING SODIUM IOTHALAMATE-$^{131}$I BY SAMPLE COUNTING METHOD AND EXTERNAL COUNTING METHOD. Tuchida, Tatsuya; Oka, Toshiyuki (Osaka City Shirokita Hospital). Radioisotopes (Tokyo), 18: 175-80(May 1969). (In Japanese).

Measurements of renal glomerular filtration rate using sodium iothalamate $^{131}$I by sample counting method in 39 cases and external counting method in 20 cases were investigated and compared with thiosulfate clearance by a single injection method performed simultaneously. First, in sample counting method, after intravenous injection of SI-$^{131}$I, samples of blood were obtained at 30 and 40 minutes, samples of urine were collected from 20 to 50 minutes. The activity of $^{131}$I in plasma and urine was measured in a well type scintillation counter in counts per milliliter per minute. All clearances were calculated by the formula C = UV/P, where C is the plasma clearance in ml/min, V the urine volume in ml/min, U the urine activity and P the plasma activity (cmp). Second, in external counting method, the plasma disappearance curve was obtained by external monitoring over the head or the heart during 60 minutes. The correlation coefficient for sample counting method and simultaneous thiosulfate clearance was 0.89, and for external counting method 0.86. These counting methods are useful clinical measurements of glomerular filtration rate, especially the external counting method without urine collection and multiple venipunctures. (auth)

**29617** FUNDAMENTAL PROBLEMS IN SCANNING. Based on a Symposium [held in Chicago, Illinois, May 8–9, 1965]. Gottschalk, Alexander; Beck, Robert N. (comps. and eds.). Springfield, Illinois, Charles C Thomas, Publisher, 1968. 523p. $26.75. (CONF-650544).

The first section of the book is concerned with biological, chemical, physical, and nuclear parameters of the target source. The second section considers the scanning system as a whole as well as spatial resolution and problems of quantitative utilization. Collimation and detection modes are discussed in the third section with special reference to collimation of gamma rays; moving-detector scanners versus stationary imaging devices; sensitivity and resolution of the scintillation camera; area scanning with the Anger camera; applicability of vacuum image intensification chains to radioisotope imaging; and the current status of tomographic scanning. Information processing and display are discussed in the fourth section. System optimization is considered in the fifth section. Topics discussed are evaluation of system performance; the modulation transfer function for scanners; detail visibility in the presence of quantum fluctuations; and information capacity as a criterion for comparing imaging systems. (H.L.W.)

**29618** DIAGNOSIS OF TUMORS IN THE REGION OF THE ABDOMEN USING RADIONUCLIDES. Stroetges, M. W.; Sauer, J. (Ruhr Univ., Essen). Roentgenpraxis, 22: 88-99(Apr. (1969). (In German).

Modern diagnostic procedures, using radioisotopes, are discussed. Lymphoscintigraphy and liver scintigraphy are methods of choice for the localization of tumors and, in most cases, present no danger to the patient. Other methods, like spleen and kidney scintigraphy and, in certain cases, perfusion with technetium-99m pertechnetate are used for evaluation of the total disease pattern. Diagnostic application of radioisotopes is preferable to x-ray diagnostics because of the reduced risk to the patient. (H.B.G.)

**29619** FUNCTIONAL DEFICIENCY OF THE SPLEEN IN HEMOBLASTOSIS: SCINTIGRAPHIC DETECTION AND CLINICAL SIGNIFICANCE. Hennig, K.; Franke, W.-G. (Carl Gustav Carus Medizinische Akademie, Dresden). Deut. Gesundheitsw., 24: 389-93(Feb. 27, 1969). (In German).

The spleen scintigrams of 128 patients suffering from hemoblastoses, part of whom had been repeatedly examined, were tested for activity storage disturbances. The results are demonstrated by characteristic examples and by a respective synopsis. The primary unspecific changes of activity distribution are interpreted in connection with the clinical picture. Storage disturbances occurred in 29 per cent of all cases. They were caused by infarctions, infiltrating or destructive changes. The detection of intraspleenic disturbances of storage is of great clinical importance. It enables medical experts to draw conclusions to generalization and relapses, as well as to the prognosis of the basic diseases. Thus, the course of the disease can be checked. (auth)

**29620** ON THE DIFFERENTIAL DIAGNOSIS OF COMBINED MITRAL VALVE FAILURE WITH THE RADIOACTIVE ISOTOPE $^{85}$Kr. Knebel, R. Anglo-Ger. Med. Rev., 4: 24-30(Dec. 1967). (In German).

The $^{85}$Kr method was combined with the ascorbic-acid dilution method for the quantitative determination of the mitral regurgitation. Two examples are given which show that it is possible on the basis of the simultaneously obtained pressure curves in the left ventricle and in the left auricle in combination with the $^{85}$Kr method to define the portion of the insufficiency and the stenosis of the mitral failure with sufficient accuracy. (J.S.R.)

**29621** ISOTOPES AND RADIATION TECHNOLOGY. Volume 6, Number 4. Baker, P. S.; Lafferty, Robert H. Jr.; Gerrard, Martha; Greene, R. E.; McKinney, F. E.; Carden, Joan E.; Miller, F. J.; Hess, D. N. (eds.). One of the Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Laboratory, Summer 1969. 108p. GPO $0.70.

Separate abstracts were prepared for 12 chapters of this publication. Other chapters are included on availability of isotopes and services and AEC activities. (H.L.W.)

*For abstracts of individual chapters see: 28736, 28761, 28909, 28979, 29029, 29104, 29105, 29122, 29245, 29635, 29687, and 29944.*

**29622** SELECTIVE ADMINISTRATION OF SELENOMETHIONINE $^{75}$Se IN PANCREATIC SCANNING. Reuter, Stewart R.; Cohn, Howard J. (Univ. of Michigan, Ann Arbor. Wayne County General Hospital, Eloise, Mich.). Radiology, 92: 158-60(Jan. 1969).

Pancreatic scanning has not had consistent value as a diagnostic procedure because of the poor localization of the scanning agent in the pancreas following intravenous administration. In an attempt to increase relative pancreatic uptake, selenomethionine-$^{75}$Se was injected into the gastroduodenal, dorsal pancreatic, or splenic arteries. This method resulted in increased pancreatic uptake and better definition in the area of the pancreas supplied by the injected artery. It is hoped that this technic combined with angiography may improve the diagnostic accuracy in diseases of this relatively inaccessible organ. (auth)

**29623** SCINTIGRAPHIC INVESTIGATION OF THE LIVER AS ROUTINE METHOD IN MALIGNANT DISEASES. Becking, H. (St. Clara Hospital, Rotterdam). Radiol. Clin. Biol., 38: 23-9(1969).

The value of radioisotope scanning for the diagnosis of liver diseases and neoplastic metastases in the liver when combined with biochemical methods of investigation. On the basis of the information thus obtained, the further diagnostic and therapeutic management of the case can be determined. The facilities for performing scintigraphic investigations should be available in every large hospital. Tracer studies have completely lost their academic character and should be applied on a much wider scale in routine examinations, for which they prove indispensable. (auth)

**29624** $^{85}$Sr SCANNING OF A "BROWN TUMOUR" IN A PATIENT WITH PARATHYROID CARCINOMA. Evens, Ronald G.; Ashburn, William; Bartter, Frederic C. (National Inst. of Health, Bethesda, Md.). Brit. J. Radiol., 42: 224-5(Mar. 1969).

A positive $^{85}$Sr scan of a benign tumor in the mandible of a patient with carcinoma of the parathyroid gland is reported. (C.H.)

**29625** THE ASSOCIATED USE OF THE BENGAL ROSE $^{131}$I AND OF THE COLLOIDAL $^{198}$Au IN THE STUDY OF THE CHRONIC HEPATIC DISEASES. Mombelli, L.; Tarolo, G. L. (Univ., Milan). Radiol. Med., 55: 31-40(Jan. 1969). (In Italian).

Twenty patients affected by chronic hepatic diseases, subdivided into three groups according to the degree of global impairment of the hepatic function, were studied using $^{131}$I bengal rose and colloidal $^{198}$Au for scanning. The results showed that both the tests were satisfactory for discrimination of the different degrees of hepatic insufficiency, though at the beginning of the disease the $^{131}$I-bengal rose was more sensitive. (auth)

**29626** SCANNING THE BRAIN WITH VARIOUS RADIOISOTOPES (MANUAL AND AUTOMATIC STUDIES IN A SERIES OF 750 PATIENTS). van Eck, J. H. M.; Woldring, M. G. (Univ. Hospital, Groningen, Netherlands). Eur. Neurol., 2: 1-12(1969).

A comparative study of brain scanning was made with $^{131}$I-serum albumin (RISA), $^{203}$Hg-Neohydrin, and $^{99m}$Tc-pertechnetate. The overall accuracy was comparable for the three isotopes and for two techniques. Altogether, out of 263 examinations on patients with a space-occupying lesion, 201 gave a positive result (76%). Although each method has its special merits, and personal skill and experience remain important tools, $^{99m}$Tc scanning is to be recommended on account of many practical advantages. A 10 mCi dose of $^{99m}$Tc will deliver no more than 1 to 2 rad to the critical organ (the upper large intestine). With 0.5 mCi RISA even a blocked thyroid would receive 18 rad, and for 0.7 mCi $^{203}$Hg-Neohydrin the exposure of the kidneys is estimated between 35 and 300 rad without diuretic pretreatment, one third of this amount after such a treatment. The low radiation dose to the patient with $^{99m}$Tc allows scanning of young children. The main shortcoming of this agent is its short shelf-life ($T_{\frac{1}{2}}$ = 6 hr), and even that of the parent isotope $T_{\frac{1}{2}}$ = 67 hr), which necessitates the regular supply of the Mo generator. (BBB)

**29627** STUDIES ON THE DIAGNOSIS OF THE INTRACRANIAL DISEASES USING RADIOISOTOPE SCANNING. Fujita, Shiro (Kanazawa Univ., Japan). Kanazawa Irigaku Sosho, 81: 37-49 (Dec. 1967). (In Japanese).

Brain scanning is useful as a screening test for the detection of intracranial diseases. There have been many radioactive isotopes used for brain scanning and since short half-life nuclides, such as $^{113m}$In, were developed, their diagnostic value has been more recognized. The higher the Tumor-to-Brain Concentration Ratio of isotope (TBR), the clearer a positive scan is delineated. TBR was measured by making use of the materials from the craniotomies as well as from the animal experiments, and by the use of phantoms on the basis of those measurements. The following results were derived from the experiments as described above. In the rats bearing Yoshidasarcoma, TBR resulted in 7.0 when RISA was used, whereas it resulted in 10.2 when $^{203}$Hg-Neohydrin was in use. TBR, obtained by the employment of materials from the craniotomies, was approximately between two and four when RISA, $^{203}$Hg-Neohydrin and $^{99m}$Tc-Pertechnetate were respectively used, and was lower than had been expected as compared with the ratio measured by the animal experiments. After the scans of the patients with brain tumor got performed, the count rates were recorded from the surface of their heads concerning the area of apparently normal brain and the area demonstrating abnormal concentration of radioactivity in the scan. The ratio shown at the time when the area of tumor and that of normal brain were counted SCR—surface counting ratio) was about two on the average. There was an increase in SCR in proportion to the larger size of a phantom when TBR was between two and four, but the increase at this time was only minimal. When TBR showed 7 or more, SCR tremendously increased. When TBR was 50 it was possible for even a sphere 1.5 cm in diameter to delineate a positive scan. This suggests that we shall be able to make a diagnosis of an extremely small lesion if radiation detection equipments are improved and new radiopharmaceutical compounds which have higher TBR are produced. The clinical application of brain scanning was investigated, particularly the percentages of positive scans of tumors, the percentages of positive scans done by each isotope and positive scan of each histology. The possibility of histological diagnosis from the scan images and the clinical value of $^{113m}$In were discussed. The positive percentage of all the neoplastic lesions was 76.2%. From the standpoint of isotope, RISA 82.2%, $^{99m}$Tc 69.7% and $^{113m}$In 83.0%. From the viewpoint of histology, both meningioma and glioma showed the best positive percentage 100%, next craniopharyngioma 85.7% and metastatic tumor 80.0%, but cerebellar tumor and cystic tumor did not show satisfactory results. The positive scans were visible in A-V malformation, abscess and hematoma among non-neoplastic diseases. The brain scan images were classified into some patterns based upon each histology or diagnosis in order that we might be able to determine the histology or diagnosis from the pattern. The clinical application of $^{113m}$In and the diagnostic value brought about by the improvement of recording procedures or radiation detection equipment. (NSA of Japan) (TSS)

**29628** PRACTICAL APPLICATION OF THE RADIOISOTOPES $^{45}$Ca, $^{85}$Sr, AND $^{51}$Cr IN ORTHOPEDIC SURGERY. Patryn, A. (Orthopedic Clinic, Warsaw). Pol. Tyg. Lek., 23: 1143-5(1968). (In Polish).

The possibilities of using certain radioisotopes such as $^{45}$Ca, $^{85}$Sr, and $^{51}$Cr in orthopedic studies are considered. With the use of these radioisotopes it is possible to investigate mineralization processes in bone tissue, osteoblastic remodelling at the site of fractures, and growth of epiphyseal cartilage. Moreover, $^{85}$Sr can be used for estimation of bone sarcoma activity and topography. Based on the results of investigation with these radioisotopes, resections and amputations were performed. The need for more investigations, especially biological experiments, is emphasized. (BBB)

**29629** TECHNETIUM $^{99m}$Tc SERUM ALBUMIN. Di Chiro, Giovanni; Ashburn, William L.; Briner, William H. (National Inst. of Health, Bethesda, Md.). Arch. Neurol., 19: 218-27(Aug. 1968).

The use of high specific activity $^{99m}$Tc-labeled human serum albumin (HSA) as a tracer for subarachnoidal and ventricular scintiphotography is described, methods for its preparation are discussed, and some results of its use are evaluated. Among the agents that have been used for studying the spinal and endocranial cerebrospinal fluid pathways by external detection, $^{99m}$Tc-pertechnetate has almost ideal physical characteristics: 6-hr half life, lack of $\beta$ emission, and single 140-keV $\gamma$ photon. By labeling albumin with $^{99m}$Tc, the favorable physical characteristics of $^{99m}$Tc and the advantageous biological behavior of albumin can be combined. The absorbed radiation dose to the brain, spinal cord, and the whole body from a 2-mCi dose is considerably lower than that delivered by a 100-$\mu$Ci dose of $^{131}$I-labeled albumin. If a low specific activity $^{99m}$Tc-HSA is used, aseptic meningitis may be produced by the injection of relatively large amounts of protein. In the method described as little as 2 mg of human serum albumin are labeled with routine efficiencies exceeding 80%, and having specific activities ranging from 3 to 12 mCi/mg of albumin. Occasionally, $^{99m}$Tc-HSA myelography offers information not obtained with conventional radiographic studies. (BBB)

**29630** THE RADIOISOTOPE RENOGRAM. Joekes, A. M.; Sherwood, T. Medical Monograph No. 4. Amersham, Eng., Radiochemical Centre (UKAEA), 1967. 13p.

A short historical note on this subject is first given, followed by a detailed description of the technique. The basic units required for radioisotope renography are two matched NaI(Tl) scintillation-photomultiplier counters linked to ratemeters that feed into a two-channel recorder. Other units could be added to the system, for example a third counter to monitor blood activity over the heart. Sodium o-iodohippurate ($^{131}$I or $^{125}$I) was the agent used. Advantages in using $^{125}$I were mentioned. It was also stated that there were theoretical reasons for considering that a rubidium renogram ($^{86}$Rb) could give interesting information. For renal scintigraphy chlormerodrin labeled with $^{197}$Hg or $^{203}$Hg was employed, and its successful use in renography was reported. Amongst matters discussed were dosing, inhibition by other agents such as penicillin, and clinical use and interpretation of the technique. (UK)

**29631** CLINICAL ASSESSMENT OF RADIOPNEUMONOGRAPHY WITH $^{133}$Xe IN CONFRONTATION WITH ANGIOPULMONOGRAPHY AND ELECTROKYMOGRAPHY. Agranat, V. Z.; Kalantarov, K. D.; Korsunskii, V. N.; Marmorshtein, S. Ya. Med. Radiol., 13: No. 12, 29-35(Dec. 1968). (In Russian).

Data comparing the results of investigations on regional ventilation and pulmonary circulation obtained by means of radiopneumonography with $^{133}$Xe, electrokymography and angiopneumonography were presented for 67 patients suffering from different diseases of the lungs. Agreement of the results of radiopneumonography and electrokymography in the study of regional ventilation and pulmonary circulation was noted in 74 and in 79 per cent of patients. A comparison of radiopneumonographic and angiopneumonographic data showed correlation in 60 per cent of patients. The technique of radiopneumonography yields additional information in addition to data derived with the aid of electrokymography and angiopneumonography. (auth)

**29632** CLINICAL EVALUATION OF RADIOISOTOPE RENOGRAM IN TRAUMATIC PARAPLEGICS. Furuta, Atsuhiko; Kondo, Masaru (Kanto Rosai Hospital, Japan). Nippon Saigai Igakkai Kaishi, 15: 207-14(Oct. 1967). (In Japanese).

Studies on radioactive renography by $^{131}$I-Hippuran were done in 32 traumatic paraplegics. The results were as follows; Pathological findings of both or one kidney were noticed in 26 out of 32 patients. The characteristic signs of pathological findings were a lowered secondary phase and the delayed function of the third phase. The finding of I.V.P. corresponded to the renograms in 80% of the whole cases. The findings of I.V.P. were normal and that of renograms were abnormal in six out of seven cases in which the findings of I.V.P. did not suit that of renograms. Renograms of the sitting position were compared with those of the supine position in the same patients. No change of excretory pattern was observed in normal healthy adults (control). Most of the traumatic paraplegics showed normal renograms in the sitting position, but abnormal renograms curve in the supine position. The patient lay supine with each probe directed over the anterior aspect of each kidney. A catheter was inserted into the bladder, through which $^{131}$I-Hippuran was passed and the condition of the vesicoureteral reflex was observed. (auth)

**29633** COMMENT ON "RADIOACTIVE PHOSPHORUS IN THE DIAGNOSIS OF GASTROINTESTINAL CANCER." Job, Jose Martins (Casimiro de Abreu, Porto Alegre, Brazil). Gastroenterology, 55: 560-1(Oct. 1968).

An experimental model for use of $^{32}P$ to detect cancer of the gastrointestinal tract is reported. In dogs the mucosa of the duodenum and proximal jejunum had a $^{32}P$ uptake greater than that of the mucosa of the stomach. In humans the ratio between the radiophosphorus uptake of a gastric cancer and that of the gastric mucosa adjoining the neoplasm is usually the same as the ratio between the $^{32}P$ uptake of the intestinal and gastric mucosa of dogs. Substituting a piece of the proximal small bowel for a portion of the gastric wall produced in the stomach of dogs the conditions that prevail in cases of human gastric cancer, regarding response to the radiophosphorus test. Several pieces of intestinal mucosa of varying sizes were placed in different positions: e.g., near the cardia or the pylorus, in the anterior or posterior wall, in the dog stomach. Radiophosphorus was then given intravenously in an amount equivalent to the dose used in humans. It was taken up by both the gastric mucosa and the mucosa of the transplanted intestinal patch. A small Geiger tube was introduced into the stomach through the esophagus and its position monitored by fluoroscopy. Under the best counting conditions, the rate of detection in vivo was 80%. (BBB)

**29634** BALANCE STUDIES AND $^{47}Ca$ KINETICS IN CHRONIC RENAL INSUFFICIENCY. Gossmann, H. H.; Schaumloeffel, E.; Habermehl, A.; Baltzer, G.; Graul, E. H. (Philipps-Univ., Marburg, Ger.). Klin. Wochensch., 46: 1052-5(Oct. 1, 1968). (In German).

Five patients with chronic renal insufficiency were injected intravenously with 30 to 40 $\mu$Ci of $^{47}Ca$ (as $CaCl_2$) with a specific activity of 50 to 100 mCi/g. Blood samples were taken one hr to 14 days later. Enteral absorption and renal excretion of $^{47}Ca$ were markedly decreased in chronic renal failure. Excretion of $^{47}Ca$ into the gut was normal, and by impaired reabsorption of endogenous enteral Ca a long-standing negative Ca-balance can be produced. Uremic patients frequently eat a low-Ca diet. In the five unselected cases of chronic renal failure, high bone-turnover of $^{47}Ca$ (with normal or raised bone accretion rate) was seen in accordance with the histological findings. In spite of this, a normal serum Ca could not be maintained. Diminished Ca stores of the skeleton may be involved in the pathogenesis of this hypocalcemia but it is felt that there is mainly a cybernetic disorder of blood-bone equilibrium since low serum Ca is also encountered in the presence of a large Ca pool and in acute renal failure. Hypocalcemia and decreased absorption probably protect the body from extraosseous calcification. (BBB)

**29635** SURVEY OF THE USE OF RADIONUCLIDES IN MEDICINE. Williams, K. D.; Sutton, J. D. (Public Health Service, Washington, D. C.). Isotop. Radiat. Technol., 6: 415-24(Summer 1969). (MORP-68-10).

The results of the first phase of a survey on the use of radionuclides in medicine in the United States are reported. Tables are presented to show radionuclides used in medical diagnostic and therapeutic procedures during 1966, frequency of radionuclides used in organ scanning, radionuclides used in research studies performed in 1966, and a comparison between 1959 and 1966 studies by principal radionuclides. (H.L.W.)

**29636** RESULTS OF SCINTIGRAPHY OF BRAIN TUMORS. Brenner, H. (Univ., Vienna); Deisenhammer, E.; Hoefer, R.; Jellinger, K.; Pernhaupt, J. G. Wien. Klin. Wochensch., 81: 209-13(Mar. 21, 1969). (In German).

Brainscans were performed with technetium-99 or $^{203+18}$Neohydrin on 69 patients with histologically confirmed brain tumors. Results showed 71% positive tumor localization; 87% of cerebral tumors, 94% of glioblastomas, and 75% of astrocytomas. Scan failures occurred mainly with small tumors located infratentorially or close to the sella. Transport and accumulation processes in tumor tissue are discussed. (H.B.G.)

**29637** ANTIBODIES LABELLED WITH RADIOACTIVE IODINE AND THE POSSIBILITIES OF THEIR APPLICATION IN IDENTIFYING BACTERIAL INFECTIONS. Herzmann, H.; Ocklitz, H. W.; Weppe, Ch.-M. (Deutsche Akademie der Wissenschaften, Berlin). Isotopenpraxis, 5: 14-16(Jan. 1969). (In German).

Dispepsia coli O 111 was identified in homogenized stools by means of antibodies labeled with radioactive iodine $^{131}I$. Altogether, 307 examinations of 171 children were carried out, whereby the radioimmunological test has been checked by cultures and immunological fluorescence. The radioimmunological technique failed in 22 samples = 7.2 per cent of cases only, i.e., the positive results obtained by the conventional methods could not be confirmed here, but this fraction of falsely negative statements is essentially below the failure rates occurring when culture or immunological fluorescence is applied exclusively. The radioimmunological test has found to be sufficiently sensitive in order to serve as the search test. (auth)

**29638** THE DIAGNOSIS OF HEPATIC METASTASES BY MEANS OF RECTALLY ADMINISTERED RADIOIODINE. Tukiainen, P.; Kivinitty, K.; Forss, M.; Unnerus, C. E. (Univ. of Helsinki). Oncology, 22: 269-72(1968).

A method for diagnosing hepatic metastases by means of rectally administered radioiodine (40 $\mu$Ci of $^{131}I$ in 10 ml of water is introduced into the rectum) was evaluated. The rate of increase in the concentration of $^{131}I$ in the liver is determined, expressed as the increase in graph-units (proportional to radioactivity) per minute recorded during the initial rapid rise after the intrarectal injection. The duration of the increase in the concentration of $^{131}I$ is also determined. The test seemed to be a useful diagnostic method for the detection of liver metastases, judging by the results obtained in 20 cases. Only 1 patient without liver metastases had an equilibrium time of over 30 min. This patient had severe cholangitis and carcinoma of other organs. The equilibration time was 14 min or more. Twenty-one patients without liver metastases had a time of 1 to 9 min. The accuracy of the test seems to be very high. The difference is probably due to the longer time required for $^{131}I$ to diffuse through the relatively avascular tumor tissue before the equilibration time is reached in the liver. (BBB)

**29639** $^{99m}Tc$ IN THYROID GLAND, SALIVARY GLAND, AND BRAIN TUMOR DIAGNOSIS. Boerner, W. (Univ., Wuerzburg, Ger.). Ber. Phys.-Med. Ges. Wuerzburg, 73: 57-68(1967). (In German).

The advantages of the use of $^{99m}Tc$ for scanning of the thyroid gland, salivary glands, and brain are reviewed. The irradiation dose to the thyroid gland from $^{99m}Tc$ is only 1/200 of that from $^{131}I$ and the resolving capability is better with $^{99m}Tc$ than with either $^{125}I$ or $^{131}I$. Thinner-walled collimators and shielding can be used with $^{99m}Tc$. A combined $^{99m}Tc$ and $^{131}I$ thyroid test can be completed within 1 day. In brain tumor diagnosis deep-lying tumors can be detected readily with $^{99m}Tc$, and larger amounts can be given without increasing irradiation dose greatly, as compared to $^{203}Hg$. The gonadal dose from an oral dose of 250 $\mu$Ci of $^{99m}Tc$ is ~3.5 mrad and the thyroid gland dose is ~50 mrad. The upper large intestine is the critical organ, and receives ~75 mrad. After administration of 5000 $\mu$Ci for brain scintigraphy the whole-body dose is 60 mrad. The upper large intestine receives 1200 or 500 mrad, if this amount is given orally or intravenously, respectively. For salivary gland scintigraphy ~750 $\mu$Ci of $^{99m}Tc$ is administered, which permits the secretory parenchyma to be clearly outlined, the functional status to be evaluated, and functional processes to be studied. The polyostotic salivary glands, including the palatinal and the posterior portion of the sublingual gland, can be visualized by means of $^{99m}Tc$. The salivary glands reach their $^{99m}Tc$ activity maxima in the sequence; parotid, submandibular, palatinal, and sublingual. (BBB)

**29640** PACEMAKER ARTIFACT IN LUNG SCAN. Blum, Manfred; Katz, Stephanie; Scapicchio, Michael (New York Univ., N. Y.). J. Amer. Med. Ass., 208: 866(May 5, 1969).

An artifact that simulated a pulmonary embolus was produced in a lung scan by an indwelling cardiac pacemaker. Postmortem study confirmed the absence of such emboli. It was found that the battery pack of the pacemaker absorbs approximately 50% of the $^{131}I$ gamma emission from the injected radioactive pharmaceutical. (auth)

**29641** RADIOACTIVE BONE SCANS IN CARCINOMA OF THE PROSTATE. Morgan, Cecil Jr.; Mills, Patrick (Univ. Hospital, Birmingham, Ala.). S. Med. J., 61: 785-90(Aug. 1968).

The sensitivity of scans made with $^{85}Sr$ for the detection of skeletal metastasis from prostatic carcinoma, and especially for identifying sites for diagnostic bone biopsy is discussed. Studies of 66 patients with prostatic carcinoma by conventional bone x rays, determinations of acid phosphatase and serum lactic dehydrogenase, bone marrow studies, and $^{85}Sr$ bone scans showed that the scans were abnormal in 68.2% of the cases and thus more sensitive than the other tests. An average dose of 75 $\mu$Ci of $^{85}Sr$ was given intravenously and the scan was made five to eight days later. Scanning earlier than this produced false positive results. Subsequent scans six months later indicated that hormonal treatment might cause changes in the scans. Where definite evidence of metastasis was obtained by abnormal x rays or examination of the bone marrow, scans were also abnormal. The $^{85}Sr$ scan was used to identify a site for bone biopsy to prove metastasis which was not apparent by other tests. The greatest value of bone scans is in patients being evaluated for curative surgery. If all other tests were normal, or equivocal, abnormal $^{85}Sr$ bone

scans could identify the location for bone biopsy or marrow aspiration to search for metastasis. (BBB)

**29642** HEMODYNAMIC STUDY OF DISEASES OF THE AORTIC ORIFICE BY ISOTOPE DILUTION CURVES. Di Matteo, J. (Hopital Necker, Paris); Picard, R.; Vacheron, A.; Kellershohn, C.; de Vernejoul, P. Bull. Soc. Med. Hop. Paris, 118: 1173-89(Nov. 17, 1967). (In French).

The dilution curves of albumin labeled with $^{131}I$ and $^{137}Ba$ were used for studying 65 aortic valve diseases. The short period of this material makes possible the injections of large dosages of labeled material. The periodic phenomenons of the cardiac activity may then be registered externally in the precordium and in the end part of the aorta. In aortic insufficiency, the dilution curve of the $^{137}Ba$ showed typical patterns and the importance of the insufficiency may be appreciated. It also gave an indication of the left ventricle condition. Repetition permits following the course of the disease. (auth)

**29643** CLINICAL APPLICATION OF EXCRETORY UROGRAPHY AND ISOTOPE NEPHROGRAPHY. Rotte, K. H.; Altenbrunn, H.-J.; Schroeder, H. (Institut fuer Krebsforschung, Berlin). Radiol. Diagn., 9: 745-50(1968). (In German).

The results of excretory urography and isotope nephrography are compared in 103 cases (mostly oncological). The results tallied in 71 cases (69%). There was a disagreement in 32 cases (31%). Isotope nephrography was, as expected, found to be more accurate for evaluation of functional disturbances. Excretory urography is better for evaluation of morphological changes. For follow-up studies of renal function, e.g., after operation or irradiation, isotope nephrography is sufficient. In severely ill patients, who can not tolerate an excretory urography, isotope nephrography is an alternative. (auth)

**29644** PLACENTAL LOCALIZATION USING $^{99m}Tc$ LABELED ALBUMIN. Jacoby, H.; Arnot, R. N.; Jeyasingh, K.; Glass, H. I.; Browne, J. C. M. (Hammersmith Hospital, London). Obstet. Gynecol., 33: 358-60(Mar. 1969).

Placental localization investigations were carried out using a dual detector scanner and a gamma camera with injected doses of 250 $\mu$Ci of $^{99m}Tc$-albumin. The dose delivered by 250 $\mu$Ci of $^{99m}Tc$-albumin was 1 mrad to the maternal whole body, 12 mrad to the maternal blood, and 4 mrad to the fetal blood. A dose of 250 $\mu$Ci was found to be necessary to ensure a satisfactory result. Technetium-99m was used in conjunction with the gamma camera for 12 patients and with a dual detector color scanner for 50 others. Localization commenced immediately after the isotope was injected. The routine dose of 250 $\mu$Ci yielded count rates of $5 \times 10^4$ to $7 \times 10^4$ cpm so that the pictures which normally were composed of 50,000 counts required an exposure time of ~60 sec on the gamma camera. The whole procedure was completed in less than 20 min. Using the gamma camera, placentas situated on the anterior wall of the uterus were visualized, but the placenta was not always well defined in posterior positions. Of the 50 patients in whom placental localization was performed with the dual detector scanner, the position of the placenta was carefully noted in 12 at cesarean section. Five of the six placentas in the upper segment had been accurately localized. In four patients with placentas in the lower segment, an accurate diagnosis of placenta previa was made. In two others described, placenta previa had not been diagnosed. The dual detector scanner procedure was preferred. (BBB)

**29645** RADIATION IN DENTISTRY: SURGICAL COMMENTS. Hoffmeister, F. Stanley; Macomber, W. Brandon; Wang, Mark K. H. (Albany Medical Center, N. Y.). J. Amer. Dent. Ass., 78: 511-16 (Mar. 1969).

The danger of self-inflicted radiation damage in dental diagnostic radiology is considered and guidelines for prophylactic extractions in patients undergoing oral irradiation are discussed, along with the factors important in determining which teeth to extract. One result of a dentist's failure to protect himself against repeated exposure to irradiation while taking diagnostic dental films is illustrated. A dentist who had been doing routine diagnostic x-ray work in his office since 1921 developed extensive irradiation dermatitis involving the right thumb, index, and middle fingers. Wide excision of the involved skin with application of a split-thickness skin graft was carried out. Microscopic examination revealed fibrosis of the dermis and subcutaneous tissue, chronic inflammatory subepidermal changes, epidermal acanthosis, focal areas of atypical squamous proliferation, hyperkeratosis, and parakeratosis, i.e., a typical picture of chronic postirradiation dermatitis. As to guidelines for prophylactic extractions, the factors important in determining what teeth to extract are: the site of the teeth (lower or upper), the port and type of radiation (ortho- or megavoltage), and the tooth pathology involved. A curve illustrating the time-effect relation between the irradiation and the circulatory efficiency of the tissues is presented. Statistics showing the incidence of major wound complications after extractions in the irradiated oral cavity suggest that the experimental data from animals are applicable to humans. This experimental and clinical information has critical bearing on the timing of the extractions in the irradiated oral cavity. In the management of postradiation necrosis and osteomyelitis, the need for a conservative surgical approach and adequate soft tissue coverage is pointed out. (BBB)

**29646** OVARIAN SCAN WITH HUMAN CHORIONIC GONADOTROPIN-$^{131}I$. Hreshchyshyn, Myroslaw M.; Kazeto, Sadayuki (State Univ. of New York, Buffalo). Amer. J. Obstet. Gynecol., 103: 434-6(Feb. 1, 1969).

Development of a new method for studying ovarian pathology, including early ovarian cancer, was investigated. The ovaries of dogs were scanned in vivo following intravenous administration of chorionic gonadotropin-$^{131}I$. Human chorionic gonadotropin (HCG), 2150 I. U./mg, was labeled with $^{131}I$ using 2 mg of HCG for 5 mCi of $^{131}I$. At 2 hr from the time of femoral vein injection of HCG-$^{131}I$, when the recorded radioactivity of the ovary reached the level of 2268 cpm, a dog was transferred to a 5-in. scanner, and the scan of the right ovary was obtained at a distance of 4 in. from the skin. Spectroscaler recordings of in vivo radioactivity of the right ovary, liver, spleen, and bladder over a 4 hr period from the time of injection of HCG-$^{131}I$ are shown. There was a progressive increase in the radioactivity of the right ovary during the first 3 hr and 15 min with apparent leveling off during the remaining 45 min. A lesser increase in radioactivity was observed in bladder, and no increase was seen in radioactivity of liver and spleen. The radioactivity of the mammary gland approached that of the ovary, and the radioactivity of the muscle (thigh) was $^1/_{10}$ that of the ovary. A satisfactory visualization of the right ovary was obtained by scanning the organ 2 hr after administration of HCG-$^{131}I$. Thus the ovary in the dog was successfully scanned following administration of HCG-$^{131}I$. This was possible because of low uptake of the radioactive material by the muscle and relatively high concentration of radioactivity in the ovary, largely in luteinized tissue, as shown by autoradiography. It is possible that the same result would be achieved with this technique in humans. (BBB)

**29647** MEASUREMENT OF PLASMA FLOW RATE AND GLOMERULAR FILTRATION RATE BY ANALOG COMPUTER ANALYSIS OF RADIOISOTOPE RENOGRAMS. Hirakawa, A.; Kuwahara, M.; Iwai, S.; Nakagawa, T. (Kyoto Univ.). Dig. Int. Conf. Med. Biol. Eng., 7th, Stockholm, 1967, 169(1967).

From 7th International Conference on Medical and Biological Engineering, Stockholm, Sweden. See CONF-670808.

An analog computer analysis was performed to quantitatively evaluate $^{131}I$-hippuran and sodium iothalamate $^{131}I$ renograms. The computer circuit for simulation of the renal excretory process is illustrated, and the diagrams of the results obtained with each labeled compound in a patient with glomerulonephritis are given. It is concluded that the model might be useful for separate measurement of renal plasma flow and glomerular filtration rate from renographic records. (C.O.)

**29648** RADIOCARDIOGRAM ANALYSIS BY ANALOG COMPUTER SIMULATION. Kuwahara, M.; Iwai, S.; Takayasu, M.; Nohara, Y.; Hirakawa, A.; Kinoshita, M. (Kyoto Univ.). Dig. Int. Conf. Med. Biol. Eng., 7th, Stockholm, 1967, 170(1967).

From 7th International Conference on Medical and Biological Engineering, Stockholm, Sweden. See CONF-670808.

A model and its analog computer circuit (closed four-compartment system) are presented for the hemodynamics of flow from right and left heart using iodine-131-labeled serum albumin as a tracer. The model is unique in that the recirculation and the effects of peripheral injection of the tracer are considered. It is then possible to quantify circulatory blood flow rate, volumes of right and left hearts, and volume of pulmonary and body blood vessels. (C.O.)

**29649** THE USE OF ERYTHROCYTES LABELLED WITH $^{99m}Tc$ PERTECHNETATE FOR SCANNING OF CARDIAC CAVITIES. Turaev, R. N.; Kuznetsov, N. S.; Kulikova, M. M. Med. Radiol., 14: No. 4, 15-17(Apr. 1969). (In Russian).

A technique is proposed for scanning of cardiac cavities with erythrocytes labelled with $^{99m}Tc$-pertechnetate. The technique is simple and accessible for a radiobiological laboratory. The radiation dose to the organism is 0.015 to 0.02 rad. (auth)

**29650** EVALUATION OF STOMATOLOGICAL ROENTGEN EQUIPMENT OF DOMESTIC MAKE FROM THE VIEWPOINT OF PROTECTION AGAINST IONIZING IRRADIATION. Zajaczewski, Zygmunt. Czas. Stomatol., 21: 545-50(1968). (In Polish).

Measurements of the size of the irradiated area during x-

radiography of the teeth were performed. It was found that the size of irradiated area differed depending on the size of the valve fenestrum and precision of head casing. The lack of proper protection caused excessive range of the patient's irradiation. These results seem to be of special importance in protection against ionizing irradiation. (auth)

**29651** LYMPHOGRAPHY OF LYMPH NODES FOLLOWING X RADIATION. Malska-Waniewska, Izabella; Studencki, Eugeniusz; Naganski, Tadeusz (Onkologische Zentrum, Lodz, Poland). Strahlentherapie, 137: 9-13(Jan. 1969). (In German).

In order to disclose if radiation modifications in the inguinal lymph nodes could be observed on the radiograms, and to detect any influence of it on the lymph flow, lymphography of the lower extremity was performed (Lipiodol Ultrafluid). The procedure was performed in 14 patients with cervical carcinoma, which were irradiated according to usual treatment techniques. It was assumed that in these patients, the radiation induced modifications in the inguinal lymph nodes were not masked by metastases. In all cases marked modifications were observed: reduction of the node number, reduction of their dimensions, more diffuse internal structure and irregular contour. No influence on these modifications was observed by time between irradiation and the lymphography (15 months to 15 years). In none of the patients, retardation of the lymph flow was observed. Radiation induced modification in the lymph nodes has no influence on the lymph flow such as occurs in case of metastatic invasion. (auth)

**29652** TECHNETIUM LUNG SCANNING. Surprenant, E. L.; Webber, M. M.; Bennett, L. R. (Univ. of California, Los Angeles). Int. J. Appl. Radiat. Isotop., 20: 77-9(Jan. 1969).

Albumin tagged with $^{131}I$ was the first and is still the most widely used agent for lung scanning; but it has several inherent limitations. In view of this, labeling with $^{99m}Tc$ was proposed, this isotope having very desirable properties for lung scanning. A method is described for preparing macroaggregated albumin–$^{99m}Tc$, and its advantages are demonstrated, employing a lung phantom. The $^{99m}Tc$ was obtained in the form of $NaTcO_4$, from molybdenum generators. (UK)

**29653** ISOTOPE RENOGRAPHY IN THE DIAGNOSIS OF RENOVASCULAR HYPERTENSION. A COMPARISON WITH AORTOGRAPHY AND EXCRETORY UROGRAPHY. Hornych, A. (Inst. for Blood Circulation Diseases, Prague); Vavrejn, B.; Oppelt, A.; Dejdar, R.; Prat, V.; Hejl, Z.; Kotkova, E.; Charvat, P. Cas. Lek. Cesk., 107: 1043-53(Aug. 23, 1968). (In Czech).

Diagnostic use of renography was investigated in 110 subjects. Isotope renography, aortography, and excretory urography were used. Of 76 patients suffering from hypertension, 16 had a significant stenosis of the renal artery. The isotope renography gave false negative results in 12.5% of the number of all stenoses and 2.6% of the total number of patients with hypertension. Isotope renography is a suitable method for the detection of renovascular hypertension. (JPRS)

**29654** OPTIMAL USE OF RADIOACTIVE PHARMACEUTICALS IN MEDICAL DIAGNOSIS. Emmons, Hamilton. Baltimore, Johns Hopkins Univ., 1968. 215p.

Thesis.

The problem of optimal selection and use of a class of drugs widely and increasingly employed in hospitals today, radioactive pharmaceuticals, is discussed. These substances are used in the laboratory and in the clinic, in diagnosis and in therapy, to study both the structure and the functioning of the body. The present study concentrates on their use in diagnostic tests in conjunction with scanners, to provide visualizations of organs, tumors, etc. The medical problems are discussed first: those that involve the patient's welfare directly. Figures of merit for isotopes are suggested that measure the clarity of the scan relative to the radiation dose to the patient. They lead to a method for estimating the optimal time after administering the drug to make observations, as well as providing a basis for comparison of different radiopharmaceuticals. The second part of the study investigates the cost of stocking radioactive substances, and models are proposed and solved which indicate the optimal inventory policy to pursue in a variety of situations. Again, they provide information pertinent to the choice of one from among several exponentially decaying substances. Finally, some comments are made on the subject of combining these results in an overall evaluation of various pharmaceuticals. (Diss. Abstr.)

## Radiotherapy

*Refer also to abstracts 29046, 29056, 29314, 29350, 29353, 29355, 29375, 29399, 29406, 29458, 29509, 29512, 29513, 29520, 29523, 29524, 29527–29530, 29532, 29593, 29596, 29597, 29713, 29825, 29829–29833, 29838, 29844, 29850, 29852, 29857, 29859, 29861, 29866, 29868, 29873, 29874, 29876, 29882–29884, 29887–29889, 29892, and 30891.*

**29655** (CONF-670649-44) RADIOISOTOPES AS THERAPEUTIC AGENTS. Belloch Zimmermann, Vicente (Valencia Univ. (Spain). Facultad de Medicina). [1967]. 10p. (In Spanish). Dep.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

The diverse possibilities in the therapeutic application of artificial radioisotopes are reported in a systematic form, with emphasis on the handling ease, practical advantages, and radiobiological principles. The types of surface, interstitial, and intracavitary application are indicated, with some discussion of teletherapy. (tr-auth)

**29656** (MORP-68-10) SURVEY OF THE USE OF RADIONUCLIDES IN MEDICINE: PRELIMINARY REPORT. Williams, Kenneth D.; Sutton, Joseph D. (National Center for Radiological Health, Rockville, Md.). July 1968. 77p.

A national survey of all licensed and/or registered medical users of radioisotopes was conducted to determine the current use of radioactive materials in medicine. Principal radioisotopes, compounds, and procedures to determine biological function (radiodiagnosis) were discussed; $^{131}I$ for diagnosis of thyroid physiology was used the most. The second most widely used was $^{57}Co$ for vitamin $B_{12}$ absorption tests. The relative frequencies of organ scanning were 37.8% thyroid, 30% brain, 16.3% liver, 6.2% kidney, 5.6% lung, and 4.1% other. Of the reported radiopharmaceutical administrations, 96.5% were for diagnosis and 3.5% were for therapy. The number of radiopharmaceutical administrations per year was found to have increased approximately fourfold during the past 7 years. (C.O.)

**29657** TANGENTIAL ROTATION BY $^{60}Co$–$\gamma$ RAY. 1. STUDY ON RADIATION METHOD AND DISTRIBUTION OF THE AMOUNT OF RADIANT RAY. Nakada, Yoshinobu (Tachikawa Hospital, Japan). Kyosai Iho, 17: 354-67(May 1968). (In Japanese).

The use of tangential rotation for $^{60}Co$ $\gamma$ irradiation for preoperative and postoperative treatment of carcinomas of the mammary gland and metastases of mammary gland carcinomas is discussed. The effects of the rotation angle and irradiation field on dose distribution were studied. Evaluation of a large number of cases led to the conclusion that tangential rotation therapy gives better therapeutic results than conventional fixed field irradiation and results in a more uniform dose to the thorax, with less radiation dose to the heart and lungs. (NSA of Japan) (TSS)

**29658** EFFECTS OF SUPERFICIAL RADIOTHERAPY ON CUTANEOUS EPITHELIOMAS. Jaqueti, G. (Hospital de San Juan de Dios, Madrid); Gay Prieto, J. pp 107-10 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 1. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In Spanish).

See CONF-670719-(Vol.1).

Two thousand one hundred forty-nine epitheliomas were treated with x radiation. The fractionated therapy techniques were described in detail. Of the total number treated, 1,795 were followed for a period of six months to three years. There were 1,710 cures, 4 absolute failures, 57 relapses, and 23 post-treatment metastases. (J.S.R.)

**29659** THERAPEUTIC INDICATIONS OF RADIOACTIVE SUBSTANCES IN DERMATOLOGY. Pierquin, B. (Institut Gustave Roussy, Villejuif, France). pp 1081-2 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In French).

See CONF-670719-(Vol.2).

The principal radioisotopes used in radiotherapy of the skin are $^{32}P$, $^{90}Sr$, $^{90}Y$, $^{137}Cs$, and $^{192}Ir$. The therapeutic indications for benign lesions and malign tumors are summarized. The endoradiotherapy of extended cancers of the skin using $^{192}Ir$ is briefly described. The results obtained during five years of therapy with $^{192}Ir$ show a good cicatrization of lesions from 5 to 7 cm in diameter where the central ulceration has not totally destroyed the Malpighi layer. There is a rapid reepidermization after radiotherapy. For lesions of larger extent and particularly for profoundly ulcerated lesions there is no rapid and complete cicatrization. However there is sterilization of the lesions and slow reepidermization. (J.S.R.)

**29660** NEW TECHNIQUE OF RADIUM THERAPY IN HIGH-PRESSURE OXYGEN. Nannelli, M.; Mantellassi, G. (Univ., Florence). pp 1088-9 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn,

W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In French).
See CONF-670719-(Vol.2).

A technique for applying radium as a moulage to the patient to be placed in a high pressure oxygen chamber to increase the radiosensitivity of tumors is described. Because the radiation source is inside the chamber, a large pressure chamber can be used. The chamber is well lighted with beds and tables and magazines. Under these comfortable conditions the emotional stresses which participate in oxygen intoxication are eliminated, and the exposure time can be increased to 2 hrs per day. In 390 treatments made in this chamber only one case of slight intoxication was observed. (J.S.R.)

**29661** PRELIMINARY INVESTIGATIVE STUDIES OF THE LASER TREATMENT OF ANGIOMAS. Goldman, L.; Rockwell, R. J. Jr.; Meyer, R. (Children's Hospital Research Foundation, Cincinnati). pp 1084-6 of XIII International Congress of Dermatology, Munich, July 31-August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.
See CONF-670719-(Vol.2).

The effects of laser radiation on port-wine angiomas of human skin were investigated. The reactions which occurred following treatment were increased redness for a brief period of time, superficial transient atrophy, some superficial scarring, and occasional revascularization. Hemorrhage was not a significant feature of the laser treatment. It was emphasized that this treatment was investigative and, perhaps, not even practical for the patient with an extensive lesion. The lightening in color was usually cosmetically acceptable; one difficulty was the reticular pattern produced by the circular pattern of the impact areas. It was concluded that the laser treatment of angiomas is a form of investigative surgery and should not supplant conventional therapy when such conventional treatment is required and is available. (C.O.)

**29662** PSORALEN THERAPY OF VITILIGO IN THE TROPICS. Fleisher, T. L. (Ashford Medical Center, Santurce, Puerto Rico). pp 1124-5 of XIII International Congress of Dermatology, Munich, July 31-August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.
See CONF-670719-(Vol.2).

The treatment of vitiligo with trimethylsporalen and subsequent midday tropical Sun exposure was evaluated. The treatment induced repigmentation. Facial repigmentation occurred first and was usually complete within less than a year. The hairy trunk and extremity areas repigmented more slowly. The distal extremities repigmented more slowly and partially. Repigmentation was not related to the duration of disease. (C.O.)

**29663** COMBINATION TREATMENT OF MYCOSIS FUNGOIDES WITH X RADIATION AND MITOTIC INHIBITORS. Wiskemann, A. (Univ., Hamburg). pp 1125-6 of XIII International Congress of Dermatology, Munich, July 31-August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In German).
See CONF-670719-(Vol.2).

Fifteen patients with mycosis fungoides were treated with Colzemide and Proresid 16 hrs before irradiation with 300 R x radiation. Of the 15 patients, 12 responded satisfactorily to this combined treatment. (J.S.R.)

**29664** LASER SURGERY OF ANGIOMAS WITH SPECIAL REFERENCE TO PORT-WINE ANGIOMAS. Goldman, L.; Ritter, E. J.; Rockwell, R. J. Jr.; Meyer, R.; Henderson, B.; Kitzmiller, K. Wm. (Childrens Hospital, Cincinnati). pp 1388-90 of XIII International Congress of Dermatology, Munich, July 31-August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.
See CONF-670719-(Vol.2).

Studies over the past four years showed that the laser can be used as a safe but limited form of investigative surgery for many types of benign and malignant vascular lesions, especially the port-wine lesion. Scarring and telangiectasia were minimal and the treatment was safe. (TSS)

**29665** PRESENT AND FUTURE PROSPECTS FOR CHEMOTHERAPY OF THE LEUKEMIAS. Zubrod, C. Gordon (National Cancer Inst., Bethesda, Md.). pp 475-80 of Proceedings of the International Conference on Leukemia-Lymphoma, Ann Arbor, Michigan, October 9-13, 1967. Zarafonetis, Chris J. D. (ed.). Philadelphia, Lea and Febiger, 1968.
See CONF-671073.

There is an urgent need for methods to measure the number of leukemic cells in the patient after each course of therapy. When the numbers of cells to be killed can be measured, then therapy that is adequate without being excessive can be planned. There is also a need for a fuller understanding of the relation between the mitotic state of leukemic cells and drug susceptibility. This will permit further extension of the use of the drugs for selective toxicity to the leukemic cell. The need to separate what is best management for the present time for the patient seen in practice and what is to be done in the future is emphasized as we study the possibility of complete leukemic cell destruction and cure. For attempts at complete cell destruction and maximum opportunity for increased life expectancy, the physician should plan the management of the leukemia with a team of physicians at one of the leukemia centers. (C.O.)

**29666** THERAPY OF ACUTE LEUKEMIA IN CHILDHOOD. Zuelzer, Wolf W. (Children's Hospital of Michigan, Detroit). pp 451-61 of Proceedings of the International Conference on Leukemia-Lymphoma, Ann Arbor, Michigan, October 9-13, 1967. Zarafonetis, Chris J. D. (ed.). Philadelphia, Lea and Febiger, 1968.
See CONF-671073.

Methods currently in use for obtaining remissions in childhood acute leukemia are discussed. The various drugs and drug combinations are considered and mention is made of the role of radiation in control of cerebrospinal leukemia. (C.O.)

**29667** TREATMENT OF CHRONIC LEUKEMIA. Moloney, William Curry (Harvard Medical School, Boston). pp 447-50 of Proceedings of the International Conference on Leukemia-Lymphoma, Ann Arbor, Michigan, October 9-13, 1967. Zarafonetis, Chris J. D. (ed.). Philadelphia, Lea and Febiger, 1968.
See CONF-671073.

It is apparent that in many patients with chronic lymphatic leukemia the disease pursues an indolent course and therapy is not indicated. When treatment is required, several agents are capable of inducing remissions but these usually are incomplete and there is little evidence that survival time has been significantly prolonged. One must conclude that at this time treatment of CLL is unsatisfactory. While $^{32}P$ or busulfan brings about complete remissions in the majority of patients with chronic granulocytic leukemia little progress has been made in the past decade in the treatment of this disease. Survival time has not been greatly increased and present methods of treatment do not offer much hope for improvement in this regard. It is obvious that future advances in the treatment of both forms of chronic leukemia await the development of a better understanding of the fundamental aspects and pathogenesis of these disorders. (auth)

**29668** PANEL DISCUSSION OF TREATMENT OF LYMPHOMAS. pp 433-44 of Proceedings of the International Conference on Leukemia-Lymphoma, Ann Arbor, Michigan, October 9-13, 1967. Zarafonetis, Chris J. D. (ed.). Philadelphia, Lea and Febiger, 1968.
See CONF-671073.

Included in this discussion were questions and answers on the topics of supervoltage therapy effects on bone marrow, the occurrence of pericarditis in radiotherapy, management of brain metastases of acute lymphatic leukemia in children, the value of lymphangiography in diagnosis and therapy, the value of drug-radiation combination treatment, and complications arising after radiotherapy. (C.O.)

**29669** CHEMOTHERAPY OF THE LYMPHOMAS. Karnofsky, David A. (Sloan-Kettering Inst. for Cancer Research, New York). pp 409-22 of Proceedings of the International Conference on Leukemia-Lymphoma, Ann Arbor, Michigan, October 9-13, 1967. Zarafonetis, Chris J. D. (ed.). Philadelphia, Lea and Febiger, 1968.
See CONF-671073.

Drugs with measurable therapeutic activity include the polyfunctional alkylating agents (nitrogen mustard, thio-tepa, chlorambucil and cyclophosphamide), the adrenal steroids, antimetabolites, vinca alkaloids, procarbazine and anticancer antibiotics. The indications for these agents differ in Hodgkin's disease, lymphosarcoma and reticulum cell sarcoma, but in most patients an adequate trial at the appropriate stage of the disease should be made. Investigational drugs are being examined for therapeutic activity in the lymphomas; they include BCNU (1,3-bis(2-chloroethyl)-1-nitrosourea), arabinosyl cytosine, vinca alkaloid derivatives, antitumor antibiotics and L-asparaginase. Conventional agents are being evaluated when given in combinations with or without x-ray therapy. Methods used in the clinical evaluation of the antilymphoma drugs in relation to the biological characteristics of the lymphomas are discussed as a possible approach to the development of more effective chemotherapy. (C.O.)

**29670** THE RESULTS OF RADICAL RADIOTHERAPY IN HODGKIN'S DISEASE AND OTHER LYMPHOMAS. Rosenberg, Saul A.; Kaplan, Henry S. (Stanford Univ., Palo Alto, Calif.).

pp 403-8 of Proceedings of the International Conference on Leukemia–Lymphoma, Ann Arbor, Michigan, October 9–13, 1967. Zarafonetis, Chris J. D. (ed.). Philadelphia, Lea and Febiger, 1968.

See CONF-671073.

From a review of clinical results of Hodgkin's disease and lymphoma cases, it was concluded that diagnostic advances resulting from the more routine use of lymphangiography and the tolerance of patients to wide-field radiotherapy, carried to tumoricidal doses, justify a new attitude of optimism in the treatment of the lymphomas. Clinical studies are also providing important information on the natural history of the lymphomas and the probable superiority of radical extended field megavoltage radiotherapy for the treatment of Stages I, II, and III Hodgkin's disease. (C.O.)

**29671** HODGKIN'S DISEASE: RADIOTHERAPEUTIC EXPERIENCE. Lampe, Isadore; Fayos, J. V. (Univ. of Michigan, Ann Arbor). pp 393-401 of Proceedings of the International Conference on Leukemia–Lymphoma, Ann Arbor, Michigan, October 9–13, 1967. Zarafonetis, Chris J. D. (ed.). Philadelphia, Lea and Febiger, 1968.

See CONF-671073.

Of 410 patients with Hodgkin's disease treated with radiation from 1940 through 1962, 288 were treated initially at our institution. The histologic diagnosis was confirmed in 268 cases by a special review for this report. In 175 patients treated from 1940 through 1955, the factors of sex, age, and stage were analyzed in relation to survival rate. The 5-year survival rate in males was 27.2% contrasted to 41.0% in females. Within each stage, the 5-year survival was found to decrease with increasing age. The Stage I 5-year survival rate was 45.2%; Stage II, 42.9%; and Stage III, 13.4%. The overall survival rate was 32%. The 5-year survival rate was noted to be higher in the more recent case material: 25.8% for the years 1940 through 1949 compared to 40.6% for the years 1950 through 1957. The granulomatous form of Hodgkin's disease comprised 82.9% of the cases; the sarcomatous variety 13.7% with only one 5-year survivor. The incidence of paragranulomas was 3.4%. Stages I and II patients treated in the earlier years with low-radiation doses (400 R program) had a 29.4% 5-year survival contrasted to 55.6% in the patients treated with higher dose (2,000 R program); the difference is significant statistically. (auth)

**29672** TELECOBALT SPLIT FIELD DOSIMETRY. WITH SPECIAL REFERENCE TO CENTRAL PENUMBRAL ISODOSE SEPARATION. Mould, Richard F. (Royal Marsden Hospital, London). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 152-6(Jan. 1969).

A formula was derived from experimental data for 60 cm, 70 cm, and 80 cm source-skin distance (SSD) fields that enables the 20% and 30% central penumbral split field isodose separations to be calculated. $S = [0.98 \cdot d''] + [\gamma \cdot SSD] + [\delta \cdot D] + \epsilon$, where d'' is the shadow of the shield at the depth of interest D, below the phantom surface, and $\gamma$, $\delta$, and $\epsilon$ are functions of percentage isodose value. The variation of dose beneath the center of the shielded area is indicated. The relationship between the depth dose along the central axes of the field portions adjacent to the shielded area, and the central axis depth doses of open fields of the same shape is discussed. (auth)

**29673** TREATMENT OF EWING'S SARCOMA WITH CONCURRENT RADIOTHERAPY AND CHEMOTHERAPY. Hustu, H. Omar; Holton, Charlene; James, David Jr.; Pinkel, Donald (St. Jude Children's Research Hospital, Memphis). J. Pediat., 73: 249-51(Aug. 1968).

Combined effects of radiation and chemotherapy in five cases of Ewing's tumor were studied. All cases showed complete regression of apparent disease within four weeks, and none has experienced local recurrence or metastases. Of the five patients, aged seven to 21, three had tumors in the leg, one in the shoulder, and one in the pelvis. Although Ewing's sarcoma is radiosensitive, local recurrence after irradiation and before metastases is not unusual. Also, this tumor extends locally in bones, into soft tissues, and by way of lymphatics. Therefore, a dose of 5000 rad was used and the ports were extended to include the entire bone and surrounding soft tissues. When the disease involved the metaphyses or epiphyses, the ports were extended to the adjacent joints, but at a lower dose level. The $^{60}$Co therapy was delivered in 4½ to 5½ weeks. Chemotherapy consisted of vincristine, 1.5 mg/m$^2$, administered intravenously on alternate weeks for one yr. Systematic toxicity consisted of leukopenia and peripheral neuropathy, but leukopenia was not serious. Muscle atrophy within the radiation ports was a consistent local sequela. One patient had a fracture of the affected tibia several months after completion of radiotherapy, but it healed normally. (BBB)

**29674** RADIATION THERAPY IN HORSES. Dixon, R. T. (Univ. of Melbourne). Aust. Vet. J., 43: 508-13(Nov. 1967).

Gamma and X radiations were useful in the treatment of granulomatous lesions, and selected neoplasms responded well to $\beta$, $\gamma$, and X radiation. The last was particularly useful in the treatment of ocular neoplasms and corneal vascularisation. Treatment of non-infectious inflammatory conditions of the carpus has given up to 60-80% success, and similar conditions of the metacarpophalangeal joint responded well in 60-70% of cases. The value of the figures is increased by the fact that many of the patients had already been treated by other methods without success, so that spontaneous recovery could almost certainly be ruled out. Better results were usually achieved in acute and early cases than in chronic, long-standing ones. Rest after irradiation gave much better results, and it is recommended that at least 60-90 days complete rest from work be given following radiation therapy for inflammatory conditions of bones, joints, and tendons. (auth)

**29675** "UNTREATED" CARCINOMA OF THE LARYNX. Norris, Charles M.; Peale, Augustin R. (Temple Univ., Philadelphia). Ann. Otol., Rhinol., Laryngol., 77: 468-76(June 1968).

In 16 cases of laryngeal cancer, removed at the time of laryngoscopy and treated no further, reasons are offered for withholding radiotherapy. Reasons for avoiding irradiation in the treatment of benign lesions such as papilloma of the larynx, benign thyroid or thymus disease and benign cervical adenitis are also cited. Unnecessary irradiation of the cervical and upper mediastinal areas in early life is strongly suspected as a significant causative factor in subsequent thyroid cancer or malignant degeneration of benign papilloma. In the adult, this sequence is thought to be a much less important problem, but 7 cases of thyroid carcinoma have been reported among 162 cases receiving from 500 to 1600 R for tuberculous cervical adenitis from 11 to 27 yr previously. In a study of 23 adults with thyroid cancer, 70% had a history of previous irradiation in dosage from 500 to 6000 R between the ages of 18 and 63 for thyrotoxicosis or tuberculous adenitis, with a possible latent period of 5 to 14 yr. Another study reported 45 cases of supposed radiation-induced carcinoma of the pharynx and larynx in which irradiation had been given for thyrotoxicosis from 20 to 44 yr previously. In 3 further cases, the interval following irradiation until the recognition of carcinoma of the larynx or hypopharynx was 13 to 32 yr. In 4 cases of malignant degeneration of benign adult papilloma the interval following irradiation was from 5 months to 15 yr. Whereas the latent period for induced carcinoma following conventional voltage irradiation and Ra therapy is from 10 to 50 yr, the latent period for megavolt irradiation is undetermined. The justification for withholding irradiation in the cases described here lies in the fact that all patients except for 2 dying of intercurrent coronary artery disease, are living, well and clinically free of carcinoma. This applies to the untreated cases as well as to 5 in which irradiation was ultimately given. (BBB)

**29676** PROPOSAL OF A NEW CONCEPT IN RADIOTHERAPY. Berger, Hans Ekkehard (Univ., Tuebingen, Ger.). Aerztl. Forsch., 21: 66-7(Feb. 10, 1967). (In German).

Malignant tumors may start to metastasize even more rapidly than before if the first dose of ionizing radiation or of drugs chosen is too low. The situation can be explained in terms of a compensation dose associated with an uncompensated and compensated dose range. Model experiments with HeLa cell cultures confirmed these views. (auth)

**29677** RADIOTHERAPY OF TUMORS OF THE KIDNEY AND RENAL PELVIS. Stender, H.; Berndt, G. (Medizinische Hochschule, Hanover). Roentgen Bl., 21: 69-78(Feb. 1968). (In German).

Factors that affect irradiation technique for treatment of renal and renal pelvic tumors are described and discussed. The degree of sensitivity of the adjacent healthy tissues limits the critical dose. The critical dose for liver, stomach, and intestine is 4500 R. For the contralateral kidney and spinal marrow the doses are 2500 and 3000 R, respectively. For large volumes $^{60}$Co therapy is appropriate, but sieve irradiation is adequate for many applications. To protect the contralateral kidney and the spinal marrow the radiation beam should be directed 10 or 15° cranially. With right-sided tumors the lateral fields should be reduced because the liver is in the beam path, or a second oblique field should be substituted. The recommended pattern of fields is illustrated for $^{60}$Co and conventional x irradiation. Wedge filters are advantageous in $^{60}$Co therapy, because dose peaks can be avoided and the dose in the lateral fields can be halved. Irradiation tolerance is improved by diet, but alternated cytostatic therapy and fractionated irradiation treatment should be avoided. (BBB)

**29678** MEDULLOBLASTOMA: A REVIEW OF PROGNOSIS AND SURVIVAL. McFarland, Dan R.; Horwitz, Harry; Saenger,

Eugene L.; Bahr, Gustave K. (Univ. of Cincinnati). Brit. J. Radiol., 42: 198-214(Mar. 1969).

Published reports over the last 30 yrs regarding clinical aspects of medulloblastoma are reviewed with special reference to factors influencing prognosis and survival. The experience at University of Cincinnati College of Medicine is added. Analyses are made concerning the long-term outlook in patients surviving primary surgical and radiation therapy. The behavior of the disease and the complications occurring in treated patients are described. The importance of adequate irradiation to the posterior fossa is emphasized and the need for prophylactic radiotherapy to the spinal canal is acknowledged, but the necessity for similar prophylactic irradiation to the cerebral hemispheres is questioned. Newer therapeutic approaches such as intraspinal radioisotope and drug treatment and systemic chemotherapy are also reviewed. Residual neurological defects resulting from the disease (or from its treatment) are frequently seen in survivors, and certain long-term hazards exist associated with extensive irradiation of the cerebrospinal axis. With current methods of therapy the disease appears to be permanently arrested in about 25% of the patients. There is evidence to suggest that survival times may be longer in older patients and that the outlook for females is better than for males. (70 references) (auth)

**29679** HIGH DOSE-RATE TREATMENT MOULDS BY AFTER-LOADING TECHNIQUES. Joslin, C. A. F.; Liversage, W. E.; Ramsey, N. W. Brit. J. Radiol., 42: 108-12(Feb. 1969).

The design and clinical applications of a high dose rate $^{60}Co$ $\gamma$ applicator are described. The applicator consists of a lead storage container, which may be shaped to fit the surface to be treated, into which two- or five-Ci $^{60}Co$ sources are inserted, after the container is attached to the patient, by means of remote handling equipment. The patient is kept in a shielded room during the treatment period. The loading technique reduces the radiation hazards to personnel, and the dose to the patient is controlled by the number of sources inserted. The applicator has a wide range of therapeutic applications. Applications for the post-operative treatment of the chest wall and abdomen following the removal of sarcomas are described. (C.H.)

**29680** CYTOGENIC ASSESSMENT OF RADIOSENSITIVITY OF CARCINOMA OF THE UTERINE CERVIX. Cox, L. W.; Stanley, Margaret A.; Harvey, N. D. M. (Queen Elizabeth Hospital, Woodville, Australia). Obstet. Gynecol., 33: 82-91(Jan. 1969).

A cytogenic method was used to evaluate radiosensitivity of cervical cancers in 60 patients. After the initial biopsy from the cervical tumor, a single exposure of 500 rad was given to the whole pelvis by external megavoltage $\gamma$ radiation. A repeat biopsy was taken 24 hr later and a third biopsy at 48 hr, the first intracavitary application of radioactive sources ($^{60}Co$) being made immediately afterward. At each $^{60}Co$ insertion, another biopsy was taken. When no mitotic figures were seen after the first intracavitary irradiation, a definite prognosis of radiosensitivity was given. Radiation-resistant patients exhibited no radiation damage to mitosis after 500 rad; mitotic activity continued after intracavitary treatment, and few of these metaphases exhibited damage. In radiosensitive tumors, radiation damage occurred throughout the period of radiotherapy. Any mitotic figures occurring after intracavitary treatment were present in very small numbers, and almost all exhibited radiation damage. (BBB)

**29681** OVER-ALL RESULTS IN RADIOTHERAPY FOR CARCINOMA OF THE CERVIX. Fletcher, Gilbert H.; Rutledge, Felix N. (M. D. Anderson Hospital and Tumor Inst., Houston, Tex.). Clin. Obstet. Gynecol., 10: 958-64(Dec. 1967).

Complications occurring following the radiation treatment of cervical carcinoma are examined in relation to dose, type of radiation, and technique used, with reference to 90 patients. Since 1954, a 22-MeV betatron was available, making possible whole-pelvis irradiation because of its penetrating beam (80% depth dose at 10 cm). Whole-pelvis irradiation was used extensively from Stage $II_B$ on, and also in Stages I and $II_A$ in some cases. Whole-pelvis irradiation and less localized Ra or transvaginal therapy was used for cervical stump carcinomas. Whole-pelvis techniques with megavoltage radiation alone, or combined with intracavitary Ra therapy, delivered radiation doses close to the maximum tolerance. The classic complications caused by Ra were rectal ulcers at the level of the posterior fornix, bladder ulcers, and recto-vaginal and vesicovaginal fistulae (this almost always occurred in Negro patients). Rectosigmoiditis, sigmoiditis, and small bowel complications were essentially caused by external radiation. In 1959, the change from the roentgen to the rad unit added 7% to the radiation dose given. This relatively small increase in dose produced a drastic increase in the incidence and severity of complications. Therefore, great care must be exercised in the use of whole pelvis irradiation with attention to all the factors involved, i.e., dose determination, the true size of the portal (also considering the penumbra), and the pelvic structures covered. For Stage $II_B$ and even Stage $III_A$, doses probably should never exceed 4000 rad to the whole pelvis. In Stages $III_A$, 1000 rad through a narrow asymmetrical portal can be added on the side involved. (BBB)

**29682** DERMATOLOGIC SYMPTOMS IN PATIENTS WITH POLYCYTHEMIA VERA BEFORE AND AFTER TREATMENT WITH RADIOPHOSPHORUS, $^{32}P$. Lukowska, Irena; Krasnik, Witold (Klinika Dermatologiczna, Poznan, Poland). Pol. Tyg. Lek., 22: 417-20(Mar. 20, 1967). (In Polish).

Observations were conducted on 50 patients, 28 females, aged 22 to 67 yr, and 22 males, aged 31 to 70 yr, with active polycythemia vera of one to 10 yr duration. The diagnosis was based on clinical, hematological, and bone marrow findings. The patients were studied to determine the effects of radiation after a single intravenous injection of $NaH_2{}^{32}PO_4$ at a dose of 3.5 to 7.00 $\mu$Ci. Following the treatment, remission was noted in clinical and hematological parameters. As a rule, distinctly favorable results were noted after three months, in some cases after six months. Usually, within this period, the swelling of liver and spleen was reduced, and some organs returned to their normal size. The hemoglobin level decreased, also the number of red and white cells and platelets. Changes of the skin and oral mucosa cleared gradually, the bluish-red discolorations of the face, hands, and feet disappeared; however, slightly visible teleangiectases remained. Varicose veins and trophic changes on shins failed to improve; the ulcerations formed granulations and new scars became visible. Thrombotic changes cleared up in all except one case that necessitated the amputation of the lower limb. Tendencies toward idiopathic and posttraumatic bleedings receded; also, the symptoms of bleeding under fingernails disappeared. Excessive sweatings stopped in all except one patient, and skin itch vanished in 36 patients, while in the other 14 patients it was greatly relieved. (BBB)

**29683** BONE MARROW GRAFTING IN RADIUM THERAPY. Gabelov, A. A.; Koiro, M. A.; Pushnitskina, A. D.; Khachkuruzova, E. S.; Kholin, V. V.; Shmidt, N. K. (Leningrad Inst. for Graduate Studies). Med. Radiol., 13: No. 12, 9-14(Dec. 1968). (In Russian).

Bone marrow grafting as a method of treating radiation leukopenia was carried out in patients with cancer of the female reproductive organs. Sternal bone marrow biopsies were used to autograft material. After proper dilution it was introduced into the ulnar vein. In parallel studies the effectiveness of other methods of stimulation of hematopoiesis was assessed. It was shown that a favorable influence on the outcome of radiation leukopenia could be achieved with the use of many previously known preparations. At the same time the possibility of attaining a desirable effect with the aid of bone marrow autotransplantation was demonstrated. However, the discrepancy of the clinical material and difficulty of considering all the factors involved in hematopoiesis in such patients did not allow conclusions to be made on the degree of effectiveness of autografting in comparison with other techniques. (auth)

**29684** THE PLACE OF PREOPERATIVE IRRADIATION IN THE MANAGEMENT OF CARCINOMA OF THE BRONCHUS. Monk, Ian; Richards, H. J.; Woods, William (Royal North Shore Hospital, Sydney). Med. J. Aust., 1: 661-2(Apr. 1968).

Effects of irradiation on bronchial tumors when given preoperatively and influence of irradiation on recovery from surgical intervention are reported with reference to 54 patients. They received radiotherapy in doses of 2000 to 2500 rad over five to seven days. The tissue irradiated encompassed the primary growth and the neighboring mediastinal lymph nodes, anterior and posterior opposing fields, usually 12 cm wide by 15 cm high. The patient was either operated on immediately after the cessation of irradiation, or within one to two weeks after treatment. In six cases in this series a heavier dose was employed, and the treatment was given with the field previously described, but the dose was raised from 3000 to 4000 rad, over three to four weeks. The first 28 patients received conventional x-ray therapy, but in the treatment of the remaining 26 patients, $^{60}Co$ was used. Only 11 patients survived for longer than one yr and one patient is alive five yr after the commencement of treatment. Serious morbidity occurred in only one case. In none of these cases was the preoperative irradiation considered a factor in the death of the patient after operation. The microscopic appearance of a bronchoscopic biopsy specimen of an anaplastic carcinoma is shown after radiotherapy. Tumor foci were surrounded by extensive fibrosis. The rationale of preoperative irradiation is that the beam sterilizes the better oxygenated cells at the periphery of the tumor. Thus shrinkage is centripetal and a fixed tumor, for example, may become more mobile, and therefore may be more safely resected. Prolonged methods of radiation

treatments impose a severe strain on the patient, both physically and mentally, and after operation there is a higher rate of postoperative complications. In one series in which a heavy dose regime was used, 29% of patients suffered from complications such as gangrene, wound dehiscence, and fistulas. Fibrosis in the area of lung irradiated may occur up to 6 to 12 months following treatment. In a radiograph of such a patient, the changes correspond to the geometric shape of the treatment beam which was used originally. A patient affected by postirradiation fibrosis may experience cough, dyspnea, and pain, and is especially prone to respiratory infections. The pulmonary fibrosis may also cause obstruction to the lesser circulation with pulmonary hypertension and right heart failure. (BBB)

**29685** EXTRACORPOREAL IRRADIATION OF THE BLOOD AND LYMPH. Baisogolov, G. D.; Levin, Yu. M.; Nikitina, R. G. Med. Radiol., 13: No. 12, 67-74(Dec. 1968). (In Russian).

A review is given of history and application of extracorporeal blood and lymph irradiation for therapy. Descriptions are given of various experiments and results that confirm the usefulness and effectiveness of leukocyte therapy by the above methods and indication that in some cases the extracorporeal blood irradiation prolonged the life span of the patient. Extensive references included. (R.V.J.)

**29686** ON THE PROBLEM OF RETROPERITONEAL FIBROSIS. Mattelaer, J.; Madersbacher, H.; Marberger, H.; Maenhoudt, R. (Univ., Innsbruck). Wien. Klin. Wochensch., 81: 203-9(Mar. 21, 1969). (In German).

Frequently, inflammations, tumors, or irradiation of the retroperitoneal area lead to fibrosis and sclerosis of the loose connective tissue surrounding the ureters and form a sheath that interferes with ureteral flow. Especially, neoplastic processes and retroperitoneal metastases of an occult carcinoma cause this type of cancerous periurethritis. The primary carcinomas are located predominantly in the intestinal tract, the reticuloendothelial system, and the genital organs. Therefore, suspicion of retroperitoneal fibrosis requires a thorough examination of the patient, especially with respect to the gastrointestinal tract and the hematological system. (H.B.G.)

**29687** POSSIBILITY OF TUMOR THERAPY WITH $^{252}Cf$ RADIATION. Atkins, Harold L. (Brookhaven National Lab., Upton, N. Y.). Isotop. Radiat. Technol., 6: 410-15(Summer 1969). (BNL-12919).

The possibility of using $^{252}Cf$ as a source of radiation for tumor therapy is discussed, together with theoretical bases for the suggested advantages of this source. (auth)

**29688** RADIATION THERAPY. A VALUABLE ADJUNCT IN THE MANAGEMENT OF CARCINOMA OF THE URETER. Brady, Luther W.; Gislason, G. John; Faust, Donald S.; Kazem, Ismail; Antoniades, John; David, James A. (Hahnemann Medical Coll. and Hospital, Philadelphia). J. Amer. Med. Ass., 206: 2871-4(Dec. 23-30, 1968).

In the interval from 1948 through 1964, 34 patients with carcinoma of the ureter were seen. Six of these patients were referred for radiation therapy. Of this number, two received postoperative radiotherapy following biopsy of nonresectable tumor, two received postoperative radiotherapy for extensive regional disease where complete surgical extirpation was not possible, and two received radiotherapy for proved recurrences of disease. Significant periods with the patient free from disease can be obtained when adequate radiation dosages are employed, with three of five patients surviving five years without evidence of recurrence. Radiation therapy should be employed in those patients in whom only biopsy is possible, for those patients with extensive regional disease where surgical extirpation is not complete, and for recurrences following definitive surgical management. (auth)

**29689** IRRADIATION OF PULMONARY TUMOR WITH OVERLYING ARTIFICIAL CARDIAC PACEMAKER. Hildner, Frank J.; Linhart, Joseph W.; Poole, Darrell O. (Mount Sinai Hosptial, Miami Beach, Fla.). Radiology, 92: 148-9(Jan. 1969).

The effects of $\gamma$ radiation on the performance of an artificial cardiac pacemaker implanted in a human patient were evaluated following therapy for a pulmonary tumor. Doses of $^{60}Co$ $\gamma$ radiation exceeding those administered for therapy did not result in obvious defects in pacemakers either immediately or after three months after in vitro exposure. (C.H.)

**29690** RECENT TRENDS IN THE RADIOTHERAPY OF HODGKIN'S DISEASE. Tubiana, M. (Institut Gustave Roussy, Villejuif, France). Indian J. Cancer, 4: 55-63(Mar. 1967).

The radiation treatment of Hodgkin's disease is considered in terms of use of highest possible doses and acceptance of some injury to normal tissues. The introduction of high energy x ray therapy and improvement of radiotherapeutic techniques allow a high proportion of patients with Hodgkin's disease to be irradiated under the optimal conditions, with good result. Statistical analysis of long-term results of radiotherapy shows that when a more aggressive approach is used cures are more likely to occur. Thus, one report showed that there is a 40% incidence of local recurrence when the dose was below 2000 rad, 33% between 2000 and 3000 rad, and 19% between 3000 and 4000 rad. It was estimated that the optimal dose lies between 3500 and 4000 rad in one month. Another report showed a 93% incidence of recurrence for areas receiving less than 1000 R, 52% for those receiving between 1000 and 2000 R, 49% for a dose between 2000 and 3000 R, and 10% for those treated with more than 3000 R. In the change from conventional to higher energy radiotherapy it is necessary to increase the dose by 10 to 15%. The question as to whether it is better prophylactically to irradiate adjacent lymph node areas or wait for clinical recurrence before treating is discussed. In Hodgkin's disease as in cancer in general it seems better to attempt to obtain a definite result from the first course of treatment. (BBB)

**29691** THE VALUE OF RADIOTHERAPY IN THE MANAGEMENT OF ESOPHAGEAL CANCER. Pearson, J. G. (Royal Infirmary, Edinburgh). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 500-13(Mar. 1969).

No present available method of treatment cures more than 20 per cent of an appreciable proportion of the patients developing this disease. Judging by the Edinburgh experience, after megavoltage irradiation, although local failure is common, the expectation of long survival is better than it is after operation. The main reason for this difference is the absence of treatment mortality following irradiation. For carcinoma of the lower thoracic esophagus, surgery is quite frequently successful and of proved value in a large series of patients. At this level radiotherapy has not yet received an adequate trial but should probably be preferred to surgery for patients over the age of 60 to 65 years and for patients who for other reasons are not good surgical risks. In Edinburgh the value of megavoltage irradiation is being investigated when used as the only initial treatment for squamous cell carcinoma at all levels in the esophagus, including the cardia. Twenty out of 99 patients are alive 5 years after irradiation; each has a normal stomach, a normal voice, is well nourished and leads a normal life. (C.O.)

**29692** AN EVALUATION OF THE MANCHESTER SYSTEM OF TREATMENT OF CARCINOMA OF THE CERVIX. Schwarz, George (Albert Einstein Coll. of Medicine, Bronx, N. Y.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 579-85 (Mar. 1969).

The results of the treatment of carcinoma of the cervix by the Manchester method are compared with results obtained by other techniques. The techniques which have yielded superior results have stressed treatment individualization and whole pelvis external irradiation prior to intracavitary radium therapy when the anatomy is not suitable for the initial delivery of an adequate minimum tumor dose to the periphery of the central tumor by the radium system. (auth)

**29693** LONG TIME SURVIVALS OF PATIENTS WITH CANCER OF THE EYE AND SURROUNDING STRUCTURES TREATED WITH RADIATION THERAPY. Martin, Charles L. Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 566-78(Mar. 1969).

Complete follow-up records of 10 patients with malignant tumors in and about the eye treated with the older time-tried radiologic techniques from 1931 to 1951 are described in some detail for the benefit of the younger radiotherapists and particularly for the benefit of the younger ophthalmologists, many of whom seem to view such procedures as dangerous and of little value. The neoplasms treated were superficial lesions including those arising from the eyelids, inner canthus and conjuctiva, orbital lesions including invasions from cancer of the skin of the nose and cheek and a primary rhabdomyosarcoma, and tumors in the globe of the second eye following enucleation of the first eye for retinoblastoma. (auth)

**29694** EXPERIENCE IN THE CLINICAL EMPLOYMENT OF LINEAR ACCELERATOR. Strashinin, A. I.; Gerasimyak, V. G.; Gladinova, T. S.; Ivanova, L. V.; Morozov, A. S.; Shvartsberg, E. M. (Central Research Inst. of Roentgenology and Radiology, Moscow). Med. Radiol., 14: No. 5, 43-7(May 1969). (In Russian).

The experience of using a linear accelerator of the Mulard system with an energy of 4.3 MeV is described. Between 1965-1967 255 patients underwent treatment; of this number 100 for lung cancer, 93 for cancer of the esophagus, 30 for cancer of the urinary bladder, 32 for tumors of other localization. Notwithstanding the severe condition of patients (in 178 cases there was third stage of the disease) an immediate positive effect

was achieved in 231 (90%) patients, clinical recovery ensued in 87 (34%) cases. (auth)

**29695** BREMSSTRAHLUNG AND ELECTRON RADIATION THERAPY OF CEREBELLAR MEDULLOBLASTOMA IN CHILDREN. Khokhlova, V. V.; Badmaev, K. N. (Scientific-Research Inst. of Neurosurgery, Leningrad). Med. Radiol., 14: No. 5, 38-42(May 1969). (In Russian).

The authors summarize the first experience of betatron treatment of 17 patients with cerebellar medulloblastoma. The average survival of patients comprised 32 months. Two children survived 5 and 6 years. The results of treatment testify to the obvious effect of irradiation of the primary node of the tumor. For improvement of the results the authors emphasize the importance of proper determination of the intervals between separate courses of irradiation and their timely institution. (auth)

**29696** ORAL TISSUE CHANGES CAUSED BY RADIOTHERAPY AND THEIR MANAGEMENT. Blozis, George G. (Ohio State Univ., Columbus); Robinson, John E. Dent. Clin. N. Amer., 643-56(Nov. 1968).

Radiation effects on the mouth and dental care of the postirradiation patient are discussed. All teeth in the field of radiation should be removed. If some teeth are retained, the dental health of these patients should be kept under constant surveillance. If possible, all dental care should be completed prior to radiotherapy. The irradiated oral mucosa takes on a white appearance after ~1000 R have been delivered. This is the result of decreased mitotic activity and subsequent longer retention of the superficial cells, allowing them to proceed to a higher degree of keratinization. As these cells are lost, the mucosa becomes thin, appearing reddish. In the range of 2500 R radiation mucositis occurs. Ultimately, the mucosa is completely lost, and an ulcer develops. The ulcers often become confluent and coalesce to form very large ulcerated lesions. A fibrinous exudate may cover some of these ulcerated areas. Pharyngeal tissues appear to be more sensitive to radiation and often are the source of the patient's initial pain when eating. As the pharyngeal mucositis becomes more severe, it is further complicated by the coexisting xerostomia. Patients often have difficulty in speaking and swallowing. When it has reached this stage, topical anesthesia may be necessary so that the patient can swallow his food. A patient will begin to notice some degree of xerostomia near 1500 R and depending on circumstances (modality and portal of administration), this will usually become severe around 3000 to 4000 R. Concomitantly, candidiasis may ensue. At 3000 R, the patient may begin to notice a loss of taste, which causes a problem in providing adequate nutrition. Most of the complications that develop during therapy usually persist until therapy is completed and for two to four weeks afterward. (BBB)

**29697** RETICULUM CELL SARCOMA AND LYMPHOSARCOMA. A RETROSPECTIVE STUDY OF POTENTIAL SURVIVAL IN LOCO-REGIONAL DISEASE. van der Werf-Messing, B. (Rotterdamsch Radio-Therapeutisch Instituut, Rotterdam). Eur. J. Cancer, 4: 549-57(Dec. 1968).

In a retrospective study of 142 cases of loco-regional lymphoreticulum cell sarcoma, data were collected concerning survival, local recurrence, regional extension, distant spread, and late lymphomas. As the result of our findings some radiotherapeutic approaches were envisaged and their theoretical advantage evaluated. (auth)

**29698** COMPARISON OF RECURRENCE PATTERNS IN HUMAN LYMPHOMA AND EXPERIMENTAL LEUKEMIA. Johnson, Ralph E. (National Inst. of Health, Bethesda, Md.). Cancer, 22: 1137-9(Dec. 1968).

Recurrence patterns are reviewed for an experimental murine leukemia (L1210) and for Hodgkin's disease in man. Two distinctive patterns are evident, with recurrence of tumor exposed to ionizing radiations occurring significantly later than for nonirradiated tumor. In the experimental leukemia studies, the prolonged recurrences (survival times) of mice inoculated with irradiated cells were demonstrated to result from a retarded growth rate of sublethally damaged leukemic cells which survived irradiation and continued to proliferate. One can only speculate as to the mechanism of delayed recurrences in irradiated sites of Hodgkin's disease patients as compared to earlier recurrences in nonirradiated regions. However, recognition of these recurrence patterns may assist in the prediction of tumor control probabilities in irradiated versus nonirradiated areas on a differential basis. (auth)

**29699** FIELD CONTROL WITH $^{60}$Co GAMMA RADIATION DURING TOTAL RADIATION TIME. Taskinen, Pentti J.; Vaehaetalo, Soini (Zentralkrankenhauses von Etelae-Saimaa, Lappeenranta, Finland). Strahlentherapie, 136: 557-61(Nov. 1968). (In German).

During radiotherapy the tumor should usually be situated completely within the radiation beam. Exact treatment planning and radiographs taken in the same direction as the beam incidence were of interest, but only films taken in the same geometry as the irradiation set-up were accurate. Simulator systems were a possible solution, but a simple localization apparatus and field control radiographs during the irradiation were cheaper. Different film qualities were examined, from which the appropriate one was chosen according to its sensitivity and the incident dose. (F.F.M.)

**29700** STEREOTAXIC RADIOFREQUENCY SURGERY OF THE NORMAL AND THE ABNORMAL PITUITARY GLAND. Zervas, Nicholas T. (Beth Israel Hospital, Boston). New Engl. J. Med., 280: 429-37(Feb. 20, 1969).

The safety features of r-f irradiation of the pituitary as compared with those of radioisotope implantation and external irradiation are dealt with on the basis of 164 patients who underwent treatment for angiopathic diabetic retinopathy, metastatic breast carcinoma, and pituitary tumors. Cerebrospinal-fluid rhinorrhea was the greatest problem, and radioactive implants were the greatest offenders, probably because radiation damage to the floor of the sella turcica led to impaired healing and spontaneous perforation. In one series, cerebrospinal-fluid rhinorrhea or meningitis, or both, occurred in 25% of cases after implantation of $^{90}$Y pellets into the intact sella turcica by a suprasellar transcranial stereotaxic approach. The high-energy $\beta$ radiation presumably destroyed the intact floor of the sella turcica, permitting cerebrospinal fluid to escape into the sphenoid sinus. The frequency was high, so that the procedure has generally been abandoned. However, with careful dosimetry and placement of $^{90}$Y seeds, it is possible to practically eliminate this complication. The safety of r-f destruction depends on the dissipation of induced heat that penetrates the capsule of the pituitary. This is provided by the flow of blood through the carotid arteries and cavernous sinuses, preventing extension of heat to the more lateral oculomotor structures. The effectiveness of this heat-dissipation system was demonstrated in 141 consecutive hypophysectomies, in which only two transient episodes of visual-field defects occurred, both clearing completely within a few days. Combined use of r-f and external irradiation is also described. Ionizing radiation damage to the brain occurred only once, in a patient who was too agitated to receive the usual rotational technic. Four other patients with visual loss and eroded or enlarged sellae had malignant nasopharyngeal neoplasms (three cases) or a mucocele (one case). Two of the three patients with carcinoma improved with radiotherapy. (BBB)

**29701** SOME OPINIONS ON TREATMENT OF CANCER OF THE ESOPHAGUS. Rider, W. D.; Diaz Mendoza, R. (Princess Margaret Hospital, Toronto). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 514-17(Mar. 1969).

The fate of 446 patients with cancer of the esophagus treated mainly with irradiation, between 1950 and 1964, is reviewed. The results of all methods used are tabulated. A comparison with the best radiation data available suggests that some of the deaths are related to radiation complications. Some suggestions regarding investigation and treatment are made. (auth)

**29702** STATE OF THE CARDIOVASCULAR SYSTEM IN RADIUM THERAPY OF CANCER OF THE LOWER THIRD OF THE ESOPHAGUS. Musabaeva, L. I.; Khairushev, Zh. A.; Zabotina, Z. I.; Balmukhanov, S. B. (Kazakh Scientific Research Inst. of Oncology and Radiology, Alma-Ata, USSR). Med. Radiol., 14: No. 4, 36-42(Apr. 1969). (In Russian).

Fifty two patients with cancer of the lower third of the esophagus were examined. The single focal dose was 400 rad and interval between irradiations was 48 hr. The dose to the heart was 4800 to 6500 rad at the end of treatment. In 52% of the cases there was an ECG improvement. Decrease of the maximal and minimal arterial pressure at the end of treatment was noted in 87 to 46% of the cases, pulse rate acceleration in 69%. Deterioration of the general state and cardiovascular complaints were observed in 9 (17%) of the patients. (auth)

**29703** THE CHOICE OF THE PROGRAM OF ROTATION IRRADIATION IN TELEGAMMATHERAPY. Galina, L. S. (All-Union Scientific Research Inst. of Radiation Techniques, Moscow). Med. Radiol., 14: No. 4, 62-8(Apr. 1969). (In Russian).

Tables are presented that enable the therapist, by the size of the tumor, its depth, form, and size of the irradiated medium, to select the program of irradiation, i.e., the size of the field, angle, orientation of the irradiated volume in respect to the center of rotation and the time of single irradiation. This is applicable to $^{60}$Co apparatus Rad, Rokus, Volfram, with the active part measuring 2 cm, the distance between the source—external edge of the diaphragm being 31 cm, and the radius of rotation 75 cm. (auth)

**29704** RESULTS OF RADIOTHERAPY OF TUMORS OF THE EPIPHARYNX AND TONSILS. Schreyer, Herbert; Kahr, Ernst (Univ., Graz). Strahlentherapie, 137: 1-8(Jan. 1969). (In German).

Between 1954 and 1964, 19 patients with nasopharyngeal tumors (8 carcinomas, 9 sarcomas, one lymphoepithelioma, and one plasmacytoma) and 49 patients with tonsillar tumors were irradiated (25 carc., 23 sarc., and one lymphoepithelioma). The treatment was primary in the majority of the cases. A small group of tonsillar tumors were irradiated prophylactically after surgical excision. The treatment was given with roentgenrays (static or moving-beam) or by telecobalt (static fields). The best results were achieved for sarcomas. The telecobalttherapy is by far superior to roentgenrays. (auth)

**29705** CALCULATION OF DOSE DISTRIBUTION FOLLOWING TELETHERAPY USING A DIGITAL COMPUTER. III. THREE-DIMENSIONAL METHOD WITH $^{137}Cs$, $^{60}Co$, AND ULTRAHARD X RADIATION UP TO 42 MV. Fehrentz, Dieter; Kuttig, Helmut; Braun, Gerhilt (Univ., Hidelberg. Deutsche Krebsforschungszentrums, Heidelberg). Strahlentherapie, 137: 18-27(Jan. 1969). (In German).

The method of computer calculation for isodose distribution in coplanar irradiation technique for telecobalt, as described in the first and second part of this work, is extended to any irradiation technique with telecesium, telecobalt and betatron-photon radiations, with energies up to 42 MV. Some examples are presented, as calculated in three dimensions for telecobalt. The comparison of different distribution obtained in the irradiation of the uterus with telecobalt, 15 MV and 42 MV photons discloses a clear advantage for the former, from the point of view of integral and skin dose. (auth)

**29706** TUMOR RADIOTHERAPY UNDER REGIONAL HYPEROXYGENATION. Ambesi, G.; Nervi, C.; Cortese, M.; Casale, C. (Istituto Regina Elena per lo Studio e la Cura dei Tumori, Rome). Radiol. Med., 55: 193-206(Mar. 1969). (In Italian).

After a brief analysis of the physiological and radiobiological aspects of irradiation under hyperoxygenation, the technique of intraarterial infusion of hydrogen peroxide contemporary to external irradiation as employed in 65 patients is described. Data about tolerance and complications of the method are discussed. The analysis of results obtained in three groups of patients with different tumors allowed the authors to conclude that the intraarterial infusion of hydrogen peroxide is a useful method to increase the oxygenation of a tissue to be irradiated if the equipment for hyperbaric breathing of oxygen is not available. (auth)

**29707** LEUKOPLAKIA OF THE VOCAL CORDS IN RADIOTHERAPY. Hommerich, K. W. Arch. Klin. Exp. Ohren-, Nasen- Kehlkopfheilk., 188: 363-8(1967). (In German).

Indications for surgical or radiotherapeutic procedures are discussed. The preference must be based mainly on histologic findings. Generally, inflammatory cell reactions, caused by smaller doses, make irradiation approaching a full tumor dose the method of choice. (H.B.G.)

### *Blast and Thermal Effects*

**29708** (BNL-13559) THYROID NODULES AS A LATE EFFECT OF EXPOSURE TO FALLOUT. Conard, R. A.; Sutow, W. W.; Colcock, B. P.; Dobyns, B. M.; Paglia, D. E. (Brookhaven National Lab., Upton, N. Y.). Apr. 11, 1969. 19p. (CONF-690404-4; SM-118/8). Dep. CFSTI.

From Symposium on Radiation-Induced Carcinogenesis, Athens, Greece.

An account is given of thyroid abnormalities that have developed during the past five years in a Marshallese population accidentally exposed to radioactive fallout in 1954 when a thermonuclear device was detonated at Bikini. Estimated body burdens of $^{140}Ba$, $^{45}Ca$, $^{131}I$, $^{103}Ru$, $^{89}Sr$, and rare earths in Rongelap people are tabulated. The largest dose to the thyroid gland was from radioiodines. In addition to $^{131}I$, the isotopes $^{132}I$, $^{133}I$, and $^{135}I$ also contributed to the dose. Since 1964 increasing numbers of cases of thyroid nodularity have developed in the exposed people. Ninety percent of children exposed at less than ten years of age have developed such abnormalities. Surgical exposure of the thyroids of 12 children and two adults revealed that the gland was multinodular, and the microscopic diagnosis was adenomatous goiter. Correlation of thyroid findings with retardation of growth and development in exposed children is discussed. Thyroid hormone therapy was given to exposed people; some improvement in growth and development resulted from this treatment. (H.L.W.)

**29709** DERMATOLOGICAL OBSERVATIONS IN THE A-BOMB SURVIVORS OF HIROSHIMA AND NAGASAKI, JAPAN. Johnson, M.-L. T.; Taura, T.; Gregory, P. B. pp 1097-8 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.

See CONF-670719-(Vol.2).

The late effects of radiation on the skin of survivors of Hiroshima and Nagasaki were studied. It was found that the dermatological imprint of one instantaneous exposure to ionizing radiation as experienced in Hiroshima and Nagasaki included increased prevalence of recognized signs of aging, pigmentary changes, benign neoplastic lesions, and certain vascular aberrations. Malignant neoplasms were not a significant finding. (C.O.)

**29710** THYROID CARCINOMA IN ATOMIC BOMB SURVIVORS: HIROSHIMA AND NAGASAKI. Wood, James W.; Tamagaki, Hideya; Neriishi, Shotaro; Sato, Tatsuo; Sheldon, Warner F.; Archer, Philip G.; Hamilton, Howard B.; Johnson, Kenneth G. (Atomic Bomb Casualty Commission, Hiroshima). Amer. J. Epidemiol., 89: 4-14(Jan. 1969).

Previous reports from the Atomic Bomb Casualty Commission have suggested an association between atomic radiation and thyroid carcinoma and the present study provides further support for this relation. Survivors exposed within 2000 m from the hypocenter at the time of the bombing who reported acute radiation symptoms were examined in Hiroshima and Nagasaki. Three comparison groups were selected so as to match this first group on an age-, sex-, and city-specific basis. The first comparison group consisted of persons exposed within 2000 m from the hypocenter and meeting the same residence requirements, but who reported no acute radiation symptoms. The second was similar, except that the subjects were exposed between 3000 to 3499 m in Hiroshima and 3000 to 3999 m in Nagasaki, and the last consisted of persons who were over 10,000 m from the hypocenter, or not in the city. Between December 1, 1963, and December 31, 1965, 39 cases of thyroid cancer were found by systematic, clinical examination. Twelve additional cases were identified in members of the sample who were not examined during the time period. The occurrence of thyroid cancer was higher in women than in men, and showed a significant increase with the proximity of atomic bomb exposure and increase in estimated radiation dose received. However, when the subjects were less than 20 yr of age at exposure the rates were the same for both sexes. Thyroid cancer in this sample did not pursue an aggressively malignant course. Sixteen persons died with thyroid cancer but in no instance could death be attributed to thyroid cancer, despite the unequivocal histologic findings of malignancy. (BBB)

**29711** EYE FINDINGS IN ATOMIC BOMB SURVIVORS OF HIROSHIMA AND NAGASAKI: 1963-1964. Nefzger, M. Dean; Miller, Robert J.; Fujino, Tadashi (Atomic Bomb Casualty Commission, Hiroshima). Amer. J. Epidemiol., 89: 129-38(Feb. 1969).

Ophthalmologic findings are reported for 1627 residents of Hiroshima and 841 residents of Nagasaki, of whom 40% had, by early estimates, received doses in excess of 200 rad at the time of the bombing (ATB). A few were in utero ATB. As in previous studies, only two findings were related to ionizing radiation: axial opacities visible by ophthalmoscope and polychromatic changes of the posterior subcapsule visible only with the slitlamp biomicroscope. Ten percent of the Nagasaki high-dose group had axial opacities. Similar opacities were seen less frequently in all other groups. Percentages of polychromatic posterior subcapsular changes varies with age and also with radiation dose. Large differences between the cities in the frequency of such findings may be due to differences in radiation or to observer variation. Radiation-induced lens changes seem to be less frequent now than previously, and there is no reliable evidence that polychromatic changes progress to axial opacities. Only in children who were in utero ATB is there any evidence of diminished visual acuity at high dose levels. In persons of all ages visual acuity is diminished by moderate and large polychromatic changes, but few people are so affected. (BBB)

## Radiation Effects on Animals

*Refer also to abstracts 29307, 29308, 29314, 29357, 29378, 29456, 29560, 29561, 29676, and 29800.*

**29712** (PG-Report-897) RADIOBIOLOGY RESEARCH UNIT, CHAPELCROSS ANNUAL REPORT 1968. Martin, J. H. (United Kingdom Atomic Energy Authority, Annan (Scotland). Production Group). 1969. 6p. Dep. CFSTI. UK.

The transfer of the Unit from the Atomic Energy Authority to Dundee University is announced. Work related to the passage of heavy ions through tissue was continued, and studies of biochemical indicators of radiation exposure and on the influence of particulate materials on cell renewal are outlined. (UK)

**29713** SOME ULTRASTRUCTURAL CHARACTERISTICS OF RADIOLESIONS. Cabre, J. (Univ., Cadiz, Spain). pp 1083-4 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In Spanish).

See CONF-670719-(Vol.2).

Biopsy samples from patients irradiated for spinocellular carcinoma and from two patients radiated for complementary therapeutic purposes were examined by electron microscope. In the irradiated carcinoma cells the most significant ultrastructural modifications occur in the Malpighian mucous body. In the patients receiving complementary irradiation, the Malpighian mucous body has an almost normal morphology. (J.S.R.)

**29714** SENSITIZATION TO X-IRRADIATION OF MELANOMA CELLS USING ALPHA-MSH. Brown, M. Lane; Milton, G. W. (Univ. of Sydney). pp 978-9 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.

See CONF-670719-(Vol.2).

The effect of synthetic $\alpha$-melanocyte stimulating hormone on the response of mammalian melanoma cells to x radiation was studied. Cells were irradiated in a 5 $\mu$g/ml solution of $\alpha$-MSH with 88 Rads and growth rates were compared. Maximal cell death occurred in those cells incubated with $\alpha$-MSH and irradiated within 2 hr of exposure to the hormone. Control cells (no $\alpha$-MSH treatment) showed some death but recovered quickly to form monolayers within 5 days. Conversely, irradiation of $\alpha$-MSH exposed cells after 24 hr resulted in a high degree of radio-insensitivity. Cell morphology was not obviously affected by the hormone. However, surviving irradiated cells were larger and more bizarre and often amelanotic and multinucleate compared with those exposed to $\alpha$-MSH. The mechanism of action of $\alpha$-MSH on melanocytes is discussed. (C.O.)

**29715** RADIATION HEATING OF BIOLOGICAL SPECIMENS IN THE CASE OF $\gamma$-IRRADIATION. Makhlis, F. A.; Pavlov, Yu. F. (Scientific Research Inst. of the Rubber Industry, Moscow) Radiobiologiya, 9: 298-301(1969). (In Russian).

Radiation heating of a specimen depends substantially on the integral absorbed dose and its rate. In the interval of dose rates provided on the existing $\gamma$ installations and at the usual sterilizing doses (up to 3 Mrad), the increase in the temperature of the specimen does not exceed 10 to 15°. The material of the container in which irradiation is performed may significantly influence the radiation heating of the specimen. Increasing the size of the specimen leads to an increase in the temperature developed in it during $\gamma$-irradiation. The temperature nonuniformity in the irradiation of most food products in a stationary glass container is small. Radiation heating in the case of low doses (up to 1 Mrad) can be calculated from the conditions of adiabatic heating of the specimen. (auth)

**29716** THE COMPLEX DOSE DEPENDENCE OF THE RATE OF GROWTH OF A CELL CULTURE IN VITRO AFTER EXTERNAL $\gamma$-IRRADIATION. Popov, A. S.; Mikhailova, A. A. (Inst. of Biophysics, Moscow). Radiobiologiya, 9: 290-7(1969). (In Russian).

The results of a determination of the number of cells of the SOTs strain 1, 2, 3, and 4 days after external $\alpha$-irradiation at doses from 3 to 900 rad are cited. At all periods of observation, the dependence of the number of cells on the dose is expressed by a complex curve, consisting of two exponential functions, the slopes of which differ by 40-fold. The number of cells recorded on the first day at doses of 50 rad and above is significantly below the number of cells inoculated; moreover, this decrease increases as the dose is increased. In $\gamma$-irradiation, the usual sigmoid dose curve was obtained. It is believed that the cause of the phenomena detected in the case of $\alpha$-irradiation lies in one of two processes: either interphase degeneration of a significant portion (30 to 40%) of the cells, previously unknown for strains passaged for long periods in vitro, or the unsticking of the same number of still living cells from the glass. (auth)

**29717** BIOLOGICAL EXPERIMENTS IN SPACE. Young, Richard S. Space Sci. Rev., 8: 665-89(Dec. 1968).

A review of the more successful biological experiments conducted by the U. S. Biosatellite Program is presented. The results of experiments conducted during four of the Gemini flights are briefly reviewed and résumé of the 13 experiments flown in Biosatellite II and a summary of results are included. The biological specimens of this flight were frog eggs, amoeba, wheat seedlings, pepper plants, larval and adult Drosophila, Tradescantia seedlings, Neurospora spores and vegetative cells, Tribolium confusum pupae, mature sperm and developing eggs of Habrobracon, and lysogenic bacteria. (C.O.)

**29718** EFFECTS OF X-IRRADIATION ON THE ULTRASTRUCTURE OF TISSUE CULTURE CELLS. I. ESPECIALLY, ON THE CHANGES OF RADIOSENSITIVITY AND THEIR RELATIONSHIP DURING THE GROWTH CELL CYCLE. Morita, Shinroku (Chiba Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 28: 1164-75(Nov. 1968). (In Japanese).

The effects of x irradiation of 200 R to 2500 R on mouse L-5 cells were studied to determine the relationship between the change of radiosensitivity and the ultrastructure of the cells during their cell cycle. Observations with the light microscope revealed the appearance of small particles in the nucleus, clearly stained nucleoli, and vacuoli in the cytoplasm. These changes were related to the cell cycle and the higher the radiation dose, the more frequent and earlier the changes. An electron dense nucleolus was revealed by means of electron microscopic observations. Mitochondrial changes included dense swelling that developed after cell division following low dose irradiation, and clear swelling, that followed high dose irradiation without cell division. Swelling of the endoplasmic reticulum was seen after x irradiation, and it caused the vacuolization of the cytoplasm in some cases. (NSA of Japan) (TSS)

**29719** EFFECT OF MEDIUM REPLACEMENT ON SURVIVING FRACTION AND CLONAL GROWTH OF X-IRRADIATED HeLa S3 CELLS. Masuda, Kouji (Kyushu Univ., Fukuoka). Nippon Igaku Hoshasen Gakkai Zasshi, 28: 1252-55(Dec. 1968). (In Japanese).

The effects of replacement of medium on the surviving fraction of x irradiated HeLa S3 cells cultured in vitro were studied by the single cell culture method. Eagle minimum essential medium (1959), supplemented with 20% calf serum was subjected to various doses of x radiation, in air. The medium was replaced seven days after irradiation. The dose response curve exhibited an extrapolation number (N) of 1.9 and 37% dose-slope ($D_0$) of 90 rads. It was not altered by replacement of the growth medium. For surviving colonies, medium replacement induced clonal growth; it did not alter the cell number per abortive colony or abortive colony number per dish. X irradiated Eagle medium supplemented with 20% calf serum did not affect the cell-plating efficiency of HeLa S3 cells. (NSA of Japan)

**29720** RECOVERY OF HeLa CELLS AFTER SMALL DOSES OF $^{60}$Co GAMMA IRRADIATION. Blomqvist, K.; Holsti, P.; Holsti, L. R.; Rytilae, A. (Univ. Central Hospital, Helsinki). Ann. Chir. Gynaecol. Fenn., 57: 74-6(1968).

Observations were made at low single doses of $^{60}$Co $\gamma$ rays on the recovery of cells and their survival curves after irradiation. These experiments were carried out after initial studies at high doses (150 to 600 rad), after which the cells failed to attain total recovery. After doses of 12, 25, and 50 rad there was a decrease in the number of cells on the 1st day after irradiation. An initial recovery followed on the third day. Another, more striking decrease, $^9/_{10}$ of the original value, occurred on the fourth day and a second recovery was noted on the fifth to sixth day when the dose was 12 rad, but at the doses of 25 and 50 rad there was a new decrease in cell number, after which only very little or no recovery was observed in 10 days. The phasic changes were significant, and found in all experiments. It was probable that the HeLa strain used was especially radiosensitive; even such low doses as 25 and 50 rad caused irreparable damage to the cells. Inhibition of growth was greatly dependent on the time after irradiation when growth was measured. The apparent generation time increased with dose. Growth inhibition measured at nine to 10 days after irradiation showed a greater radiation effect than did growth inhibition measured at three to four days. (BBB)

**29721** EFFECT OF RADIATION, ERYTHROPOIETIN, AND ACTINOMYCIN D ON RABBIT BONE MARROW CELLS. Veerling, J. Peter Jr.; McDonald, T. P.; Lange, R. D. (Univ. of Tennessee, Knoxville). Exp. Hemat., 13: 12-15(1967). (ORO-3457-5).

The technique of in vivo cobalt-60 $\gamma$ irradiation followed by in vitro culture of bone marrow is presented. The technique will add an additional method with which to study the actions of erythropoietin on stem cells and developing erythroid cells of the bone marrow. (auth)

**29722** RADIOSENSITIVITY OF DIFFERENT EHRLICH-ASCITES-TUMOUR MUTANTS IN VIVO AND IN TISSUE CULTURE. Bhaskaran, S.; Dittrich, W. (Univ., Muenster). Atomkernenergie, 14: 51-5(Jan.-Feb. 1969).

X-ray dose responses of two closely related Ehrlich ascites tumor clones of differential radiosensitivity in vivo are compared after cultivation in vivo and in vitro. The results show that the radiosensitivity differences of the clones observed in vivo disappeared on adaptation to tissue culture conditions. In addition, the modal chromosome number increased from diploid to near

tetraploid level and doubling time of both the clones diminished when grown in vitro. Irrespective of the cultural conditions the sensitive clone displayed oscillating type and the resistant mutant clone monotonic type of recovery curves. Furthermore, the resistant mutant clone exhibited a greater delay in phase progression and cell division after irradiation than the sensitive clone. A possible connection between this observation and the development of radioresistance by serial irradiation and its manifestation in the mutant clone is pointed out. (auth)

## Invertebrates

*Refer also to abstracts 29381, 29435, 29450, 29896, 29943, and 29948.*

**29723** PROTECTIVE IMMUNITY PRODUCED BY THE INJECTION OF X-IRRADIATED SPOROZOITES OF PLASMODIUM BERGHEI. II. EFFECTS OF RADIATION ON SPOROZOITES. Vanderberg, Jerome P.; Nussenzweig, Ruth S.; Most, Harry; Orton, Colin G. (New York Univ., N. Y.). J. Parasitol., 54: 1175-80(Dec. 1968).

The effects of x radiation on the infectivity and development of sporozoites of Plasmodium berghei were determined. Sporozoites received various doses from 200 to 20,000 rad and were injected into susceptible A/J mice. The higher the dose of radiation, the smaller the percentage of animals that became infected. Sporozoites irradiated with 2000 rad produced an infection rate similar to that obtained by controls. Doses of 6000 or 8000 rad were sufficient to prevent blood infections in all of the injected animals. Sporozoites irradiated with more than 10,000 rad never produced blood infections. Animals that developed parasitemia after receiving irradiated sporozoites showed a delay in their time of patency. Of 103 mice, each injected with 75,000 sporozoites irradiated with 8000 rad, only three developed patent blood infections. The prepatent periods of these animals were longer than those of control mice that received as few as 1000 nonirradiated sporozoites. After irradiation with 10,000 to 15,000 rad, these large doses of sporozoites (75,000/animal) failed to infect any mice. Most mice receiving 75,000 irradiated sporozoites were resistant to a later challenge with viable sporozoites. Small, but apparently mature, exoerythrocytic forms were found in the livers of rats that were injected with x-irradiated sporozoites. Such forms were more numerous after a low dose of radiation, i.e., 2000 rad, and persisted in the liver for at least 16 days after sporozoite injection. There may be a relation between the presence of these forms and the protective immunity found in mice inoculated with irradiated sporozoites. (BBB)

**29724** X RADIATION OF ONCOMELANIA FORMOSANA, SNAIL HOST OF SCHISTOSOMA JAPONICUM: EFFECT ON REPRODUCTIVITY AND MORTALITY. Chi, Lois Wong; Boeller, Francia (California State Coll., Dominguez Hills). Amer. J. Trop. Med. Hyg., 17: 900-3(Nov. 1968).

Snails were x irradiated with 5000 to 20,000 R and mated with nonirradiated snails. Complete sterility and mortality within six months was found in the 20,000 R group. When the irradiated male snails were mated with nonirradiated females, the males were sluggish, and mating activity decreased during the first 24-hr period. Only 12% of the irradiated males mated (none from the 20,000-R group). Of the irradiated females, 90% mated in the first 24 hr. The nonirradiated control snails mated less frequently (58%). As for the survival rate, during the first 20 days after irradiation no snail of either sex died in any of the dosage groups. Then snails began dying, and all 20 snails that had received 20,000 R were dead in 6 months. Some irradiated snails that had received smaller dosages (5000 and 10,000 R) survived for at least 1 yr. All males exposed to 20,000 R were sterile. None of the female snails that mated with them laid viable eggs. In the lower doses (5000 and 10,000 R), some females laid viable eggs. After a temporary sterility period, the number of young produced monthly by irradiated snails was again less than the number produced by control snails, indicating a period of reduced fertility. When female snails were irradiated and mated with nonirradiated male snails, the sterility was less striking. More of the females produced viable eggs. The temporary sterility period was shorter and lasted only one month in the 10,000 R group. Thus, x radiation had a greater damaging effect on spermatozoa than on eggs. For the purpose of snail-population control, it would seem more advantageous to irradiate the male snails rather than the females. (BBB)

**29725** INDEPENDENCY OF INHIBITION OF IMAGO FORMATION IN SARCOPHAGA PUPAE UPON DOSE-RATE. Sakka, Masatoshi (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 28: 1176-9(Nov. 1968). (In Japanese).

Pupae of Sarcophaga peregrine, 1 ± 0.5 day of age, were irradiated by $\beta$ rays with different intensities. The source was a round applicator which had 200 mCi of $^{90}Sr$ in 2 $cm^2$ with a surface exposure of 5350 rep per minute and the variation of intensity was produced by distance. The highest intensity was given at a distance of 15 mm and the lowest at 370 mm, the relative intensity was 1 and $1.94 \times 10^{-3}$, respectively. Dose in pupal tissues was calculated by well known formulae. Dose response relation for four different intensities was plotted on a probability paper and analyzed by probit method. The degree of inhibition of imago formation responded linearly to doses (intensity × exposure time) on the coordinate in spite of the difference by a factor of 500 in exposure rate. Independency of response upon dose rate is probably explained by the fact that at the lowest exposure rate in the present experiments ($2.58 \times 10^7$ beta particles for unit area per minute at a distance of 370 mm) the dose rate in pupal tissue is too high for recovery to occur. (NSA of Japan)

**29726** EFFECT OF GAMMA IRRADIATION ON FEMALE CULEX PIPIENS QUINQUEFASCIATUS. Smittle, B. J. (Agricultural Research Service, Gainesville, Florida). Fla. Entomol., 51: 59-61(Mar. 1968). (M-271).

Female Culex pipiens quinquefasciatus Say were exposed to 2000 to 9000 R of gamma irradiation as 1-day-old pupae. The average number of eggs per egg raft decreased with an increase in dose, and at 7000 R and above no eggs were deposited. The sterility produced by the different exposures ranged from 12% at 2000 R to 60% at 6000 R. It appears that complete female sterility due to gamma irradiation is accomplished by inhibiting egg production rather than by inducing the production of all sterile eggs. (auth)

## Vertebrates

*Refer also to abstracts 29294, 29297, 29312, 29318, 29342, 29351, 29352, 29356, 29357, 29360, 29362–29364, 29369–29372, 29374, 29387–29394, 29396, 29398, 29400–29402, 29404, 29407, 29409–29411, 29413, 29415, 29440, 29444, 29449, 29457, 29563–29568, 29570, 29571, 29573–29577, 29580, 29584, 29585, 29587–29589, 29592, 29674, 29721, and 29835.*

**29727** (AD-675041) SLEEP PROFILES OF THE MONKEY AS AFFECTED BY GAMMA-NEUTRON RADIATION. Herrmann, R. W.; Kaplan, S. J.; White, R. K.; Davis, W. F. Jr. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). June 1968. 23p. (AFRRI-SR-68-14). CFSTI.

The study indicates that the sleep patterns of the monkey, as determined by the electroencephalogram, heart rate, and electromyogram, are altered following a pulsed dose of 5000 RADS of gamma-neutron radiation. The data indicate a change in the total time devoted to sleep; however, the more notable change appears in the time distribution among the sleep stages. (auth) (USGRDR)

**29728** (AD-677598) ACUTE MORTALITY AND RECOVERY STUDIES IN BURROS IRRADIATED WITH 1Mvp X RAYS. Still, Edwin T.; Page, Norman P.; Taylor, James F.; Wisecup, William G.; Ainsworth, Earl J. (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 5, 1968. 31p. (USNRDL-TR-68-101). CFSTI.

With 1 Mvp x rays, the acute LD50/30 (midline air exposure) of adult female burros was determined to be 369 R; the acute LD50/60 was determined to be 344 R. The split-dose technique, that consists of conditioning animals with a sublethal exposure and redetermining the LD50 at various times thereafter, was used to determine the recovery pattern after an exposure to 250 R. By this method, the burro appeared to have recovered from 48% of the initial injury at 60 days and from 85% at 90 days. A bimodal death pattern was seen in the normal burros, with peaks at 2.4 and 24.2 days. The early death response was dose related. When the LD50 for 1 Mvp x rays was compared with earlier reported LD50's, it was found that there is an apparent exposure-rate-effectiveness relationship for the burro. The pattern of recovery at 60 and 90 days was found to closely parallel the return of white blood cells to normal values. The slow recovery was suggested to be a reflection of the small numbers of circulating lymphocytes that were present after the radiation exposures. (auth) (USGRDR)

**29729** (AD-678330) DOSE-RATE STUDIES WITH SHEEP AND SWINE. Ainsworth, Earl J.; Page, Norman P.; Taylor, James F.; Leong, George F.; Still, Edwin T. (Naval Radiological Defense Lab., San Francisco, Calif.). Nov. 8, 1968. 31p. (USNRDL-TR-68-96). CFSTI.

Experiments have been conducted to compare the time course of recovery for acute exposures in several species of animals. The object of these experiments is to define species differences in recovery potential, to seek the physiological basis for differences in recovery potential, and to provide both generalizations and meaningful estimates for recovery in humans subjected to acute (prompt) or protracted exposures. The purpose of this re-

port is to review dose-rate studies with sheep and to describe recent preliminary experiments with swine. (auth) (USGRDR)

**29730** (AD-680843) BEHAVIORAL AND CIRCULATORY RESPONSES TO X IRRADIATION DELIVERED AT 200 RADS PER MINUTE TO WHOLE BODY AND TRUNK ONLY. Report for June–November 1967. Chapman, Paul H. (School of Aerospace Medicine, Brooks AFB, Tex.). Sept. 1968. 13p. (SAM-TR-68-111). CFSTI.

Macaca mulatta monkeys performing a continuous avoidance task received high-energy x irradiation delivered to either whole-body or trunk only, at a dose rate of 200 Rads per minute. Prior to and during the 88-minute period of irradiation, performance and blood pressure were monitored in both groups of subjects. Results support the concept that, at this dose rate of radiation exposure, immediate behavioral changes seen after absorption of relatively low superlethal doses reflect radiation effects on structures located within the trunk of the subject. No significant synergism between head and trunk effects appears to exist. At higher doses, prominent signs of direct central nervous system damage determine the behavioral effect. A phase of partially reversible hypotension is demonstrated after 1,200 to 1,500 Rads are delivered at this dose rate. This hypotension appears to be due largely to an effect of radiation on trunk structures. (auth) (TAB)

**29731** (BNL-13528) RELATIONSHIP OF DOSE OF TOTAL BODY $^{60}$Co RADIATION TO INCIDENCE OF MAMMARY NEOPLASIA IN FEMALE RATS. Shellabarger, C. J.; Bond, V. P.; Cronkite, E. P.; Aponte, G. E. (Brookhaven National Lab., Upton, N. Y.). Apr. 2, 1969. 18p. (CONF-690404-5). Dep. CFSTI.

From Symposium on Radiation-Induced Carcinogenesis, Athens, Greece.

When 40 day-old female Sprague-Dawley rats were given a single exposure to $^{60}$Co-$\gamma$ irradiation in doubling increments of dose between 15.625 and 250 R, and studied one year later, the incidence of mammary neoplasia increased in an approximately regular manner with increasing dose. (auth)

**29732** (BNL-13581) ROLE OF MUTATIONS IN THE DEVELOPMENT OF RADIATION INDUCED AGING. Curtis, Howard J. (Brookhaven National Lab., Upton, N. Y.). [1967]. 12p. (CONF-690414-1). Dep. CFSTI.

From 1st European Symposium on Late Effects of Radiation, Rome, Italy.

The role of the bone marrow in the natural and radioinduced aging syndrome was investigated by scoring chromosome aberrations in these cells. Most normal animals tested showed that the chromosomes remain intact into extreme old age. However, if they received a massive dose of radiation when young, they exhibited an increased aberration rate when old. A strain of mice that spontaneously develops anemia and is very sensitive to radiation develops chromosome aberrations when old. Experiments show that this is probably not due to a failure of recovery mechanisms. It is postulated that point mutations occur spontaneously throughout the life of the animal in these cells. If they have an unstable chromosome structure, or if many such mutations are produced by radiation, then aberrations appear when the animals are old. (auth)

**29733** (CEA-CONF-1089) RELATIVE BIOLOGICAL EFFICIENCY OF 3-GeV PROTONS ON THE RAT AND STUDY OF RADIO-RESTORATION BY COMPARISON WITH $^{60}$Co GAMMA RAYS. Legeay, G.; Guenet, J. L. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires); Tardy-Joubert, Ph.; de Kerviler, H. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1967]. 21p. (In French). (CONF-681013-4). Dep.

From 1st European Congress on Radiation Protection and Exhibition on Equipment Using Low Energy and Short Range Radiation Dosimetry, Menton, France.

A study was made of the dynamics of the restoration of the injury caused by 3 GeV protons on 3 month old male rats. The dosimetry was done with small-volume ionization chambers with direct reading. The details of the calibration method were indicated by taking into account the energy mass absorption coefficients of the wall and the air for the photons used for the calibration, the linear energy transfers of the secondary electrons and the high energy protons, and the mean energies necessary for an electron and a 3 GeV proton to create an ion pair. A comparison was made between the doses measured and those calculated from the proton fluxes measured by activation of nuclear graphite. The agreement is correct to 3%. The relative biological efficiency for the 50%–30 days lethal dose compared with $^{60}$Co $\gamma$ was 1.09 ± 0.06. This value can not however be extrapolated to man because of the volume differences, primarily. The conditioning irradiation, producing the injury whose restoration was studied, was made at 350 rads and represents ⅔ of the 50%–30 days lethal dose. The complementary dose or the dose for the detection of injury by a new lethal dose was administered at 50 to 20 days and 2 to 6 months, respectively. The results established that for irradiation with photons, the restoration is fast during the first five days. After a slight deflection near the 20th day, the restoration continues to increase until on the 187th day a rate showing a hyperresistance representing 40% of the conditioning dose was reached. For irradiation with 3 GeV protons, an initial fast restoration is followed by a deflection on the 20th day. The residual injury remains then slight without a radioresistance appearing at 166 days. (tr-auth)

**29734** (CONF-690404-3) BONE CANCER INDUCED BY INTERNALLY-DEPOSITED EMITTERS IN BEAGLES. Dougherty, Thomas F.; Mays, Charles W. (Utah Univ., Salt Lake City. Radiobiology Div.). [1969]. Contract AT(11-1)-119. 10p. (SM-118/3). Dep. CFSTI.

From Symposium on Radiation-Induced Carcinogenesis, Athens, Greece.

Osteosarcomas were the chief cause of death in adult beagles injected intravenously with bone-seeking radionuclides in citrate solution. The effectiveness of each nuclide depends on the type of radiation emitted and where this radiation is absorbed. Alpha-radiation is more effective than $\beta$-radiation, and the $\alpha$-emitters which deposit on bone surfaces are more effective than those which deposit throughout bone volume. For death with osteosarcomas 8 years after injection, values for RBE (relative biological effectiveness) based on average skeletal dose at one year before death and relative to $^{226}$Ra = 1 are: $^{239}$Pu = 6; $^{228}$Th = 8; $^{228}$Ra (MsTh) = 2.5; and $^{90}$Sr = 0.07 to 0.24. In humans $^{226}$Ra has been observed to induce bone cancers above a skeletal dose of about 1200 rads. Adjusting by the RBE factors established in dogs, the predicted lifetime doses above which bone cancers may occur in adult humans are: $^{239}$Pu = 200 rads; $^{228}$Th = 150 rads, $^{228}$Ra = 480 rads; $^{226}$Ra = 1200 rads; and $^{90}$Sr = 5000 to 17,000 rads. (auth)

**29735** (NYO-3359-7) ALTERATION OF TASTE THRESHOLDS BY LOW DOSES OF IONIZING IRRADIATION. Fifth Year Progress Report, January 1, 1968–January 1, 1969. Shaber, Gary S. (Jefferson Medical Coll., Philadelphia, Pa. Stein Research Center). Mar. 10, 1969. Contract AT(30-1)-3359. 12p. Dep. CFSTI.

The taste thresholds for saccharin, NaCl, HCl, and quinine were determined in rats and then the effects of 50 rads of x radiation directed to the tongue (taste buds) were determined. Data are presented in tabular form. All animals that were irradiated demonstrated a ten-fold decrease in their taste sensitivity for all test solutions. The decrease in sensitivity to electrolyte solutions began to appear at 6 hr and were complete at 24 hours; changes in saccharin and quinine thresholds appeared at 2 hr. The change in taste sensitivity following irradiation lasted about 72 hr. Reexamination of the rate of tritium-labeled thymidine incorporation by cells of taste buds revealed no uptake within 72 hr. The effects of colchicine on taste bud morphology revealed little morphological change within 72 hr. (C.O.)

**29736** (NYO-3728-3) BONE AND BONE MARROW KINETICS. Technical Progress Report, June 1, 1968–March 1, 1969. Gong, Joseph K. (State Univ. of New York, Albany. Research Foundation). Mar. 25, 1969. Contract AT(30-1)-3728. 91p. Dep. CFSTI.

It was found that bleeding stress can result in the demonstration of a hematopoietic defect heretofore unrecognized. This defect was shown to persist for at least 60 weeks following a single acute dose of 170 R. The usefulness of this defect as an index of radiation residual injury is obvious. Less obvious but perhaps even more important than the above is that in rats we have a marrow system which is abnormal only under extreme stress, and this stress-induced abnormality is very long lasting (half-recovery time is 29 weeks which constitutes a major portion of its normal life-span). The usefulness of such a system in the study of basic hematology is potentially very great. From the study of the various blood and marrow parameters in response to various levels of bleeding, from slight to very severe, it was possible to suggest a tentative model of the marrow response to bleeding. From such studies in the x-irradiated and control animals, a number of differences in cellular response were found between these animals. In addition, circumstantial evidence from this study would tend to verify our suggestion that the site of residual injury was in the progenitor stem cell pool. Colony forming ability of the RI marrow was studied by means of the technique of Till and McCulloch. It was shown that RI marrow had a smaller progenitor stem cell pool than the control. Bleeding of the donor animals resulted in a decreased CFU in both the RI and control animals, the control consistently

showing larger number of CFU than the RI for any given level of bleeding. Marrow circulation in dogs was found to be affected by a wide range of x-irradiation, 2.5 to 1500 R. The blood volume changes for this dose range apparently follow two patterns. At the dose range between 2.5 and 50 R, changes in volume were found to be very transient, mostly disappearing within the first day. With the dose range from 50 to 1500 R, a different power function of dose and effect was found. Here, the changes in volume remained for many days. The latter effect was probably a result of a complete destruction of the marrow sinusoid system and marrow parenchyma with resultant massive hemorrhage. However, after eight days, a fair amount of repair of the marrow circulatory system had already occurred. In dogs exposed to a midline dose of 250 R twenty months earlier, significant increase in almost all skeletal bone structures was found. The radiation-induced increase in bone volume was at the expense of the marrow volume. The overall skeletal marrow volume lost has been shown to be as high as 7.94%. There appears to be a relationship between the age of the dog at the time of irradiation and the amount of bone increase found 20 months later. For example, of the three studies made, the most impressive bone increase was found in the animal exposed when it was 20 months old, and the least impressive amount of bone increase was found in the dog exposed when it was 28 months old. (auth)

**29737** (NYO-3970-22) RADIATION EFFECTS ON LYMPHOPOIESIS UNDER CONTINUOUS LOW DOSE-RATE EXPOSURE. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). Mar. 1969. Contract AT(30-1)-3970. 19p. (CONF-681201-3). Dep. CFSTI.

From Annual Meeting of the Radiological Society of America, Chicago, Ill.

Under continuous $\gamma$ irradiation, the lymphoid tissue of the thymus could achieve a near-steady state of cell population at a dose rate of 45 rads/day or less by mechanisms of compensatory cell proliferation. Changes in the patterns of lymphoid cell population kinetics indicated that there was a considerable reserve of proliferative capacity, but the extent to which these changes were due to decreasing the generation time in each proliferating compartment, or the bringing-in of a reserve proliferating cell population, is not, as yet, clearly understood. Both mechanisms appeared important in maintaining the steady-state of lymphopoiesis. There was a reduction in mean generation time by a narrowing of the spread of cell cycle times, thereby effectively increasing the proliferation rates in the recognizable precursor compartments. There was an increase in the size of the proliferating population, possibly by an extension of the zone of proliferation. Active recirculation of all lymphoid cells and lymphocyte migration to and probably from the thymus are now well-recognized population dynamics, and there is evidence that continuous stem cell replacement by circulating cells occurs in the normal lymphoid tissues. This could provide an important homeostatic mechanism of compensatory cell proliferation that determines the rate of cell birth under the stress of continuous irradiation. (auth)

**29738** (NYO-3970-23) CELL PROLIFERATION IN LYMPHOID TISSUE AND THE SEMINIFEROUS EPITHELIUM UNDER CONTINUOUS IRRADIATION. Progress Report, June 1, 1968–May 31, 1969. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). Contract AT(30-1)-3970. 23p. Dep. CFSTI.

The normal rate of lymphoid cell proliferation in the spleen and thymus of male C57BL mice was determined. The mean cell cycle time was about 9.5 hr. The proliferation rate was highest among reticular cells in the spleen, but the renewal rate for all sizes of leucocytes was longer in spleen. The effects of antigenic stimulation on cell proliferation in spleen germinal centers are still under study. The effects of continuous irradiation on the proliferation rate in the thymus and spleen appeared to be greater (cellular depopulation) in the spleen than in the thymus. Recovery occurred in a matter of weeks in both organs at the lower dose rates but not at the higher rates even up to the time of death. Following limited exposure of the thymus in mice to continuous irradiation, near-steady state lymphopoiesis was maintained at lower dose rates, but progressive cellular depopulation occurred at the higher dose rate (70 rad/day). The cell cycle parameters established in normal mice were not significantly changed by 45 rad/day doses of continuous irradiation. Low-dose (45 rad/day) continuous irradiation of spleen germinal centers following antigenic stimulation led to an abortive proliferative phase after the first day and no significant increase in germinal center volume even after six days. Cell proliferation rates and cell cycle times were also determined in the seminiferous epithelium of $BCF_1$ mice, and these values compared to values obtained after low-dose continuous $\gamma$-irradiation. Here also, higher dose rates led to a marked decrease in the number of spermatogonial cells and mitotic cells in all tubule stages, and an increase in the number of degenerate forms present. Low dose rates (1.8 rad/day) led to a slight increase in the cell cycle time, S phase time was doubled and $G_1$ phase time decreased. At high dose rates (50 rad/day) a complete collapse of the seminiferous epithelium was observed along with depopulation of all premitotic stages of spermatogenesis and tubular disorganization. Histological and autoradiography studies are currently underway on all phases of the study. (E.R.B.)

**29739** (ORO-2975-12) A STUDY OF THE GENETIC COMPONENTS OF GROWTH AND REPRODUCTION AS THEY ARE AFFECTED BY RADIATION, TEMPERATURE, SELECTION, AND THE INTERACTION OF THESE THREE FACTORS. Progress Report, February 1, 1968–February 1, 1969. (Georgia Univ., Athens). 20p. Dep. CFSTI.

The immediate and possibly cumulative effects of $\gamma$ radiation and the interaction of radiation, selection, and temperature on reproduction and growth of field mice were studied; the relations between growth, reproduction, and temperature were also considered. Data are presented in tabular form. Generally, temperature and radiation slightly influenced body weight and composition; temperature effects on the fat component of body weight approached significance. The group held at 90°F (60°, 75°, and 90°F holding temperatures) was discontinued because of lack of offspring. (C.O.)

**29740** (ORO-3260-4) LONG-TERM EFFECTS OF RADIATION: MAMMALIAN BEHAVIOR. Technical Progress Report, February 1968–February 1969. Furchtgott, Ernest (Tennessee Univ., Knoxville. Dept. of Psychology). Feb. 28, 1969. Contract AT(40-1)-3260. 12p. Dep. CFSTI.

This study proposes to measure longitudinally general activity in a small box with an ultrasonic device as well as in an open field and swimming speed in mice irradiated as young adults and who have passed the acute radiation syndrome. Both general activity and swimming speed decline with age. Thus, if radiation hastens and/or mimics normal aging, the irradiated mice should show the behavioral decrements sooner and/or to a greater extent than control animals. The behavioral measures will be correlated with general pathological indices. (auth)

**29741** (SZS-14/68) EVALUATION OF THE ELECTROENCEPHALOGRAM (EEG) AS AN INDICATOR OF THE EFFECT OF MEDIUM AND SMALL DOSES OF IONIZING RADIATION. I. A METHOD OF QUANTITATIVE AUTOMATIC EEG ANALYSIS STRICTLY RELATED TO BEHAVIOUR AND ITS VALUE FOR RADIOBIOLOGICAL EEG INVESTIGATIONS. Michel, J.; Koch, B.; Gurath, B.; Cammann, H. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Aug. 1968. 26p. (In German). Dep.

A critical review of literature data shows that the effect of ionizing radiation on the EEG will be only determinable by a well-planned quantitative automatic EEG analysis taking into consideration the possible changes in the behavior of awake test animals, because these changes may considerably impair the evidence and reproduceability of EEG data. Therefore a procedure of a quantitative EEG analysis strictly related to behavior is proposed and presented. The result of this analysis is the EEG power spectrum in different, easily characterizable conditions of behavior of the test animals. Finally the methods and first results obtained are discussed. (27 references.) (auth)

**29742** (UCLA-12-719) MECHANISMS OF RADIATION DAMAGE IN THE MAMMALIAN FETUS AND NEONATE. Schjeide, Ole A.; de Vellis, J. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1969]. Contract AT(04-1)-Gen-12. 40p. Dep. CFSTI.

In the fetus and the newborn radiation-induced damage to DNA was especially important in selected tissues such as the glial cells of the brain (myelination), the cerebellum, cerebrum, liver, and parts of the skeletons. These cells required intact DNAs to transcribe messenger RNAs for enzymes and other proteins involved in the process of further differentiation. An important feature of many such cells was that they were not killed by moderate radiation exposures but since their further differentiations were apparently dependent upon transcription of specific messenger RNAs at precise points in the maturation process, the failure of this transcription left the cell in a retarded state. Such cells were smaller than normal, lacked certain enzymes, and contained immature mitochondria. Membrane compositions, in general, resembled those in younger specimens, but the cells lacked potentiality for further membrane differentiation. Even if complete repair did occur with time in many of these cells, it was possible that the signals for a particular differentiative step would now be out of context. Often, in the case of local irradia-

tion of a differentiating organ, the remainder of the animal appeared to pass it by. The lesion inflicted was permanent and no efforts succeeded in ameliorating such a condition. The fetus and neonate did exhibit high capacities for gross reorganization with the result that they possibly presented reasonably functional topographical units following moderate doses of radiation. Lethally damaged cells were phagocytized and consequent deletions could be filled in by movement of cells relative to one another, invasion of connective tissue, and in some cases, by regeneration of original cell populations. An interesting feature was that adjacent organs usually accommodated very well. For example, a stunted brain was exactly matched by a smaller skull even though it was unlikely that equivalent original damage was inflicted in the two organ systems. Cells of the fetus and neonate that were growing and dividing at the time of exposure to radiation were possibly killed outright. However, a certain percentage of cells survived a moderate exposure and gave rise to new cells that appeared to be quite normal in many respects. In the case of blood cells and spermatocytes normal numbers were eventually present. The possibility of leukemia developing at a later date was considered. However, in the case of growth-limited organs such as the cerebellum, a smaller number of cells appeared to be present in the irradiated neonate and organization was abnormal. (73 references) (C.O.)

**29743** (UCRL-18347, pp 82-95) CHANGES IN THE BIOELECTRIC ACTIVITY OF SCIATIC NERVE AFTER IRRADIATION WITH CYCLOTRON-ACCELERATED PROTONS. Gaffey, Cornelius T. (California Univ., Berkeley).

It was demonstrated that 500,000 rads of 47.5-MeV protons induced an immediate and total loss of neural conductivity in the sciatic nerve of the frog, (Rana pipiens), whereas 17,500 rads caused a permanent failure in excitability after 65 hours. The postirradiation time for full blockage of neural activity was found to be an inverse function of the proton dose, provided the nerve was exposed to at least 17,500 rads of 47.5 MeV protons. The dose of protons that did not alter the magnitude of the irradiated nerve's action potential, even many hours after irradiation, was 10,000 rads. This level of radiation was considered a tolerance dose. At doses less than the tolerance dose, the irradiated nerve suffered from radiation damage by exhibiting an increase in the relative refractory period, latent period, duration of the action potential, and conduction velocity. These changes occurred while the magnitude of the action potential of the exposed nerve remained unaltered. The submaximal stimulus strength decreased after about 1000 rads of irradiation. X irradiation of the sciatic nerve with 200 kV x rays produced a prompt depression of excitation at 300,000 R. The LET (linear energy transfer) values in keV/$\mu$ are listed in parentheses for the following types of radiation: 47.5-MeV protons (1.32); 910-MeV alpha particles (1.6); 200-kV x rays (3); and 5.3-MeV alpha particles (90). The RBE (relative biological effectiveness) of the types of radiation mentioned decreased as the LET values increased. (auth)

**29744** PRELIMINARY INVESTIGATION OF FAT EMBOLIZATION FROM PULSED RUBY LASER IMPACTS OF BONE. Goldman, Leon; Rockwell, R. James Jr.; Richfield, Daniel; Wilson, Claude; Franzen, Marilyn; Smith, Patricia Owens; Hyatt, Susan R. (Univ. of Cincinnati). Nature (London), 221: 361-3(Jan. 25, 1969).

A comparison was made of bone morphology in laser drilling with other methods of drilling and the use of the laser in bone surgery was evaluated. With high output pulsed laser systems there were not only thermal factors of considerable magnitude in the impact area, but also thermally induced stresses that produced localized intracellular pressures, reaching possibly a thousand atmospheres. Recoil pressures were also generated by sudden vaporization of tissues. Since such forces might develop in the marrow cavity, it was of interest to ascertain if fat embolization could develop in such conditions, and if the laser technique could also be used to test whether mechanical trauma or chemical change was responsible for the production of fat embolism. Experiments were done on the femur of rabbits and dogs, using a pulsed high output ruby laser, with pulse duration of 1.5 to 3 ms. The most consistent results for the development of fat embolization were with a pulse energy of 150 to 170 J, areas at focal point 10 to $19 \times 10^{-3}$ cm$^2$, and focused power density at bone 10 to 13 MW/cm$^2$. Control tests were made by irradiating the fat tissue of rabbits, but not the bone; no fat embolism was found. The impact areas of the femurs showed central necrotic areas, with surrounding charred zones of varying intensity. Detailed electron microscope studies were made. Microscopy of the bone showed perforations of the cortex with coagulation necrosis of the impact area, and perivascular and lymphocytic infiltration throughout the medulla; marrow fat adjacent to the impact site was not changed. There was consistent development of fat embolization in the lungs, with intracapillary collections of fat droplets. An investigation was also made of physical changes in various fat emulsions exposed to the laser, and results are described. It is recommended that laser drilling of bone in man be deferred until more adequate information is available from animal studies. (UK)

**29745** THE EFFECTS OF GAMMA IRRADIATION ON THE POSTNATALLY DEVELOPING CANINE CEREBELLAR CORTEX. II. SEQUENTIAL HISTOGENESIS OF RADIATION-INDUCED CHANGES. Phemister, Robert D.; Shively, James N.; Young, Stuart (Colorado State Univ., Fort Collins). J. Neuropath. Exp. Neurol., 28: 128-38(Jan. 1969).

The pathogenesis of the histologic effects found in the cerebellum after a standard radiation exposure on the 2nd postnatal day, was studied in beagle puppies given a single whole-body dose of 325 R of $^{60}$Co $\gamma$ radiation. Massive selective destruction of the external granular layer occurred shortly after irradiation. Although partial recovery followed, this was not sufficient to prevent permanent thinning of the internal granular layer. Growth of the molecular layer after irradiation was almost normal until the 30th postexposure day but lagged thereafter, suggesting an effect on the production of fine dendritic branches of Purkinje cells. Soon after irradiation, reduction in total cortical thickness was due to destruction of the external granular layer. At later times, the diminished width of the internal granular layer accounted for the greatest portion of the decrement. By the 10th postexposure week, reduction in the molecular layer was also a major contributing factor. Ectopic granule cell formations were present in the molecular layer by the 30th postexposure day. Rosette formation was not observed. Histologic evidence of effects on postnatal myelination was generally mild and these were largely repaired by the 10th postirradiation week. (BBB)

**29746** MECHANISM OF LYMPHOPENIA PRODUCED BY CHRONIC IRRADIATION OF THE RAT SPLEEN. Ford, W. L. (Oxford Univ.). Brit. J. Exp. Pathol., 49: 502-10(Oct. 1968).

The rat spleen in situ was subjected to a heavy, continuous dose of $\beta$ rays by attaching to it a $^{32}$P-impregnated polyethylene strip. The radiation was largely confined to the spleen and did not reach other lymphoid tissue in significant amounts. It was predicted that small lymphocytes, that are highly radiosensitive, would be killed within the spleen and that they would be replaced by the unhindered migration of small lymphocytes from the blood since a large acute dose of ionizing radiation does not immediately impair the structures responsible for lymphocyte recirculation. Consequently, it was expected that chronic splenic irradiation would produce a deficiency of small lymphocytes similar to that found during chronic thoracic duct drainage. The measured surface activity in the middle of the strips was in the range 4.3 to 5.1 rad/min at the time of application. The penetration in tissue of the $\beta$ emission from $^{32}$P was slightly beyond 5 mm from the source and was negligible beyond 10 mm. Such attachment of a $^{32}$P-impregnated strip to the antihilar surface of the spleen produced a deficiency of small lymphocytes in the blood and a profound fall in the output of small lymphocytes from a thoracic duct fistula. No other type of blood cell was affected. Control experiments indicated that the lymphopenia was brought about by radiation death of recirculating small lymphocytes that had recently migrated from the blood into the splenic pulp. It was estimated that the normal rate of migration of small lymphocytes from the blood into the spleen was at least 1.5 times the thoracic duct output. (BBB)

**29747** EFFECTS OF TESTOSTERONE ENANTHATE (NSC-1759) ON ERYTHROPOIESIS IN IRRADIATED MICE GIVEN MARROW TRANSFUSIONS. Gallagher, Neil; Warnecke, Mary Anne; Zimmer, Mary Jane (Veterans Administration Hospital, St. Louis). Cancer Chemother. Rep., 52: 627-30(Oct. 1968).

The effect of testosterone on the erythropoietic response of lethally irradiated mice given marrow cell suspensions was assessed. The uptake of radioiron in erythrocytes and splenic erythroid colonies in the testosterone-treated irradiated mice was determined and the response correlated with levels of plasma erythropoietin. The six-to-eight-week-old mice were x-irradiated with 650 R, injected with 300,000 marrow cells, and given 5 mg of testosterone enanthate. Plasma samples were taken six days later. Testerone enhanced the 24-hr incorporation of $^{59}$Fe in both the erythrocytes and spleens of mice given marrow cell suspensions, but had no measurable effect on the irradiated animals not given cells. The femoral uptake of $^{59}$Fe was unchanged in all instances. Erythropoietin in pooled plasma of lethally irradiated mice was elevated and this was further increased after testosterone administration. The same relation was noted in irradiated animals given marrow cell suspensions. Results indicated that treatment with androgens enhances erythropoietin production in the irradiated mice and suggested that the erythropoietic recovery from lethal irradiation is, in part, dependent on the action of erythropoietin. (BBB)

**29748** PLASMACYTOGENESIS IN THE LYMPHOID TISSUE OF X-IRRADIATED RATS. Paik, Nam Suk; Kim, Young Che (Catholic Medical Coll., Seoul). Theses Catholic Med. Coll. (Seoul), 12: 61-100(1967). (In Korean).

Studies on rats were made to determine whether the proliferation phenomena of plasma cells were caused by the direct effects of x rays on such organs or by the actions of the adrenocortex. Albino rats (weighing ca. 200 gm. each) were used, and their spleens, thymuses, and lymph nodes were examined 6, 12, 24, 36, 48, and 72 hr after the whole body was irradiated with 100, 200, 400 R of x ray respectively. Adrenalectomized groups were observed 14 and 17 days after the operations. The x-irradiated groups were examined 6, 12, 24, 36, 48, and 72 hr after whole-body x irradiation at doses of 100, 200, and 400 R following 14 days after adrenalectomy. In the normal groups, after x irradiation there appeared a destruction of lymphocytes and lymphocytopoietic foci and a marked proliferation of plasma cells. It was concluded that the lymphocytopoietic and plasmacytopoietic systems are independent of each other, and that plasma cells derive their origin from reticulum cells. Adrenalectomized groups (not x-irradiated) showed a marked proliferation both of lymphocytes and plasma cells. The groups that underwent x-irradiation following adrenalectomy suffered a destruction of lymphocytes, but plasma cells proliferated as in the case of the x-irradiated normal groups. From the above experimental data, it was concluded that adrenal effects have no relation with the destruction of lymphocytes caused by x-irradiation, but accelerate the proliferation of plasma cells to a great extent. However, some other factors appear to play a role in this mechanism. (auth)

**29749** PATHOLOGY OF MONKEY RETINA FOLLOWING IRRADIATION WITH AN ARGON LASER. Rosan, Robert C.; Flocks, Milton; Vassiliadis, Arthur; Rose, Heinrich W.; Peabody, Robert R.; Hammond, Ann (Stanford Medical School, Palo Alto, Calif.). Arch. Ophthalmol. (Chicago), 81: 84-8(Jan. 1969).

An Ar continuous wave laser was used in Rhesus monkeys to inflict experimental injuries in the retina of an order similar to that which might be achieved in clinical situations. The molecular absorption for hemoglobin in the blue and green Ar wavelengths greatly exceeded that of the red of the ruby laser, and it was anticipated that the Ar laser would act upon circulating erythrocytes and incite endovascular obstruction via the transfer of heat to soluble clotting factors and endovascular linings. The Ar laser lesions differed markedly from previously reported retinal injuries induced by ruby and Nd lasers and by the Xe photocoagulator. It was found possible to change fundamentally the structural patterns of the media and adventitia of retinal arteries and to thrombose consistently choroidal vessels but not retinal arteries under the conditions employed. Experiments with energies in the 0.2 to 60 mJ range and exposures of 4 to 400 msec were employed. (BBB)

**29750** MURINE RADIATION LEUKEMIA AND THE PRELEUKEMIC STATE. Ludwig, Frederic C.; Elashoff, Robert M.; Wellington, John S. (Univ. of California, San Francisco). Lab. Invest., 19: 240-51(Aug. 1968).

Radiogenic leukemia is reviewed, particularly whether an induction or enhancement response to radiation is involved, as well as present knowledge of the preleukemic state and leukemogenesis. In the leukemogenically irradiated mouse, the onset of leukemic disease is preceded by a nonmalignant phase, or latent period, following recovery from the acute radiation syndrome. The mean duration of this preleukemic state for large groups of animals is an appreciable fraction of the life span; in the individual animal, its duration is unpredictable. The survey of the literature presented is centered on investigations of the preleukemic state, tracing the various facts and theories evolved from virologic, immunopathologic, and cytogenetic approaches. Analysis of the available data suggests that the radiation-induced preleukemic state differs only quantitatively from the preleukemic state preceding spontaneous leukemia. Hence, experimental radiation leukemia is a model useful for the study of spontaneously occurring disease. Irradiation of leukemia-prone mice elicits both leukemia-inhibiting and leukemia-enhancing mechanisms. The latter entail either transient or permanent immune suppression favoring activation of tumor virus or an increase in the number of virus-susceptible cells, or both. Conditions leading to an increase in the number of tumor virus particles or of the number of susceptible cells increase the risk of leukemia. The postulate that leukemogenesis may be regarded as a probabilistic interaction between virus and susceptible cells explains many familiar features of leukemia induction and has implications for the conduct of further research. (BBB)

**29751** PHOTOREACTIVATION FROM THE EFFECTS OF 300 NM AND 250 NM MONOCHROMATIC ULTRAVIOLET RADIATION IN ALBINO MOUSE SKIN. Freeman, Robert G.; Troll, Douglas; Knox, John M. (Baylor Univ., Houston, Tex.). Tex. Rep. Biol. Med., 26: 509-12(Fall 1968).

Photoreactivation of injury resulting from 300 nm light was compared with injury resulting from 250 nm using a high intensity monochromator as the light source. The right ear of Swiss albino mice was exposed to the uv radiation. The left ear of the animals, not exposed to uv, was the control. The animals tested for photoreactivation were exposed immediately following the uv irradiation to radiation from two 20-W fluorescent lamps at a distance of four to five inches from the animals' back for four hr each day. Photoreactivation was not manifest initially in experiments with either wavelength tested because subthreshold doses of uv were given. Even with larger doses in preliminary experiments a photoreactivating effect could not be demonstrated after single uv exposures. When the uv dose was increased and repeated daily, grossly visible damage appeared in the uv-irradiated groups and photoreactivation was clearly demonstrated. A cumulative effect resulting from repeated irradiation was required to demonstrate a difference. (auth)

**29752** EFFECTS OF IONIZING IRRADIATION ON LENS CATION PERMEABILITY, TRANSPORT, AND HYDRATION. Lambert, Brent W.; Kinoshita, Jin H. (Howe Lab. of Ophthalmology, Boston). Invest. Ophthalmol., 6: 624-34(Dec. 1967).

The effect of in vivo x irradiation with doses of 1000, 3000, or 6000 R on rabbit lens permeability was studied by the $^{86}Rb$ diffusion method. At 24 hr following irradiation of the lens the rate of $^{86}Rb$ diffusion was increased and reached a maximum at one week. Over the subsequent two weeks the rate of $^{86}Rb$ diffusion decreased, although it still remained above normal. The increase in lens permeability preceded the appearance of lens opacities and was found to be dose dependent. The active transport of cations as measured by $^{86}Rb$ uptake was unaffected. Alteration in lens permeability was accompanied by an increase in lens water. The effect of in vitro $\beta$ irradiation on the permeability of the anterior or posterior lens surface was also investigated and found to parallel that of in vivo x irradiation to the entire lens. A $^{90}Sr$ applicator was used to deliver a dose of 16,000 R to the proximal lens and 272 R to the distal side. (BBB)

**29753** ALTERATION OF HEMOPOIETIC TISSUE AS A FACTOR INFLUENCING RADIOSENSITIVITY OF THE MOUSE. Smith, L. H.; Willard, H. G. (Oak Ridge National Lab., Tenn.). Amer. J. Physiol., 216: 493-8(Mar. 1969).

The postulate that survival for the individual exposed to x radiation in the $LD_1$ to $LD_{100/30\ day}$ range is related to number of hemopoietic stem cells present at the time of irradiation was tested in mice. Alterations of stem cell number before irradiation should change radiosensitivity. Syngeneic bone marrow cells ($100 \times 10^6$) injected immediately before irradiation improved 30-day survival in the midlethal exposure range. Stem cell capacity of altered hemopoietic tissue was tested in irradiated syngeneic recipients, and the results showed that: spleen cell suspensions from polycythemic donors had increased erythropoietic capacity but had normal capacity to promote 30-day survival; spleen cell suspensions from bled donors had increased erythropoietic and 30-day survival capacity; and marrow cell suspensions from polycythemic or bled donors had normal erythropoietic capacity. For normal mice, an active erythropoietic state as measured 48 hr before irradiation was to some extent indicative of greater radioresistance. Data indicate that radiosensitivity of the individual is related to the number of hemopoietic stem cells. (auth)

**29754** ULTRASTRUCTURAL CHANGES IN BENIGN AND MALIGNANT EPIDERMAL STATES IN MICE AFTER TOPICAL BETA RADIATION. Setaelae, Kai; Nyyssoenen, Otto; Lindroos, Bjoern (Univ. of Helsinki). Acta Radiol., Suppl., 265: 69p. (1967).

Test areas of mice with normal epidermis, with benign epidermal hyperplasia, and with malignant epidermal hyperplasia were irradiated once at a dose-rate of 1000 rad/9 min from a specially constructed 20-mCi $^{90}Sr + ^{90}Y$ contact source, emitting $\beta$ radiation. Samples for light and electron microscopy were taken at one, 24, and 72 hr postirradiation. There were disparities between the response of the nonmalignant and malignant epidermal cells to radiation. Normal cells and the cells of benign hyperplasia reacted similarly and appeared to be radioresistant. Compared with nonmalignant epidermal cells, the malignant cells were highly radiosensitive, and the irradiation-dependent injuries appeared earlier, developing even in the course of the first postirradiation hour. (BBB) (TSS)

**29755** EXPERIMENTAL VERIFICATION OF PERMISSIBLE RADIATION DOSES UPON EXTENDED SPACE MISSIONS (CHRONIC EXPERIMENTS ON DOGS). Grigorev, Yu. G.; Markelov, B. A.; Popov, V. I.; Akhunov, A. A.; Ilyukhin, A. V.; Tses-

sarskaya, T. P.; Sedov, A. V.; Korsakov, V. A. Kosm. Biol. Med., 2: No. 5, 3-8(Sept.-Oct. 1968). (In Russian).

A chronic experiment was carried out with the purpose of establishing permissible radiation doses that may occur during extended space missions. The experiment included 150 dogs divided into several groups which were exposed to chronic γ irradiation with doses of 25 to 150 rem per year or to chronic irradiation aggravated with acute irradiation at doses of 10 to 50 rem. The results accumulated in the course of the first year of the exposure are presented. Regular examinations of animals involving clinical, morphological, physiological, immunological, and biochemical tests suggest that a year long exposure of animals to irradiation at the given doses produced no significant pathological changes in the organisms. (auth)

**29756** THE EFFECT OF RADIATION ON THE DIISOPROPYLPHOSPHOFLUORIDATE-$^{32}$P RED BLOOD CELL SURVIVAL CURVE IN THE MOUSE. Tyson, J. W.; Dalrymple, Glenn V. (Univ. of Arkansas, Little Rock. Veterans Administration Hospital, Little Rock, Arkansas). Proc. Soc. Exp. Biol. Med., 129: 487-9(Nov. 1968).

Findings are reported that support the principle that radiation produces its major effect on hemopoiesis and not on the circulating RBC. The changes found in the DF$^{32}$P curves can be explained on the basis of bone marrow depression after x irradiation. (auth)

**29757** RESPONSE OF THE BEAGLE DOG TO $^{60}$Co GAMMA RADIATION: DETERMINATION OF THE $LD_{50(30)}$ AND DESCRIPTION OF ASSOCIATED CHANGES. Norris, W. P.; Fritz, T. E.; Rehfeld, C. E.; Poole, C. M. (Argonne National Lab., Ill.). Radiat. Res., 35: 681-708(1968).

The $LD_{50(30)}$ of $^{60}$Co γ radiation, giving as a single, bilateral exposure at a rate of approximately 15 R/min to the whole-body of 13 month-old, purebred beagle dogs, was determined to be 258 rads, expressed as the average absorbed dose. The method for computing radiation dose allows compensation for the individual variations in size of dogs. This has a significant effect on the overall result. Detailed examination of the dogs by clinical methods, hematology, blood biochemistry, and gross microscopic inspection of tissues, led to the conclusion that acute bacteremia, secondary to bone marrow damage was the primary cause of death. There were no sex-related differences. Bacteremia intervenes in the progression of the radiation syndrome as the granulocyte count approaches the critical level of about 1000 cells/mm$^3$ of blood. Thus the complete expression of biologic response versus radiation dose is masked by the invasion of bacteria. The effect of such masking on the interpretation of data related to the $LD_{50(30)}$ is discussed. (auth)

**29758** EFFECT OF PROLONGED ADMINISTRATION OF TESTOSTERONE ON NORMAL AND X-RAY RADIATED RAT SKIN. Zackheim, H. S. (Stanford Univ. School of Medicine, Palo Alto, Calif.). pp 22-4 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 1. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.

See CONF-670719-(Vol.1).

Female albino Sprague–Dawley rats of approximately 200 g were given 2.5 mg aqueous testosterone intramuscularly 3 times/week. These rats and an equal number of water-injected controls were irradiated weekly with 500 R to the midback. After 4 weeks an average of 43% thickening of the dorsal epidermis appeared in 50 to 80% of the testosterone-treated rats. There was also marked accentuation of the granular cell layer and sebaceous glands were significantly enlarged. Those treated at least 8 weeks showed 100% increase over controls. At 4 and 6 months biopsies revealed epidermal thickening in most treated rats, and suggestions of early stages of squamous cell carcinoma were observed in several animals. After 8 months differences between treated and control rats were less phenomenal, but definite foci of basal cell carcinoma appeared in 4 of the 7 treated rats. (C.O.)

**29759** ANIMAL EXPERIMENTS ON DISTANT X RADIATION OF THE SKIN. Betetto, M. (Dermatologische Klinik, Ljubljana, Yugoslavia). pp 1096-7 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In German).

See CONF-670719-(Vol.2).

Guinea pigs were exposed to soft x radiation at a distance of 1 m for 24 or 40 weeks to compare the effect on the blood picture and the gonads with unirradiated animals. When the blood cell counts of the irradiated group were compared with that of the non-irradiated group, a slow decrease of the count, especially in leukocytes and lymphocytes, was apparent. Visible damage to the gonads occurred in the 12th week of irradiation. (J.S.R.)

**29760** STUDIES ON INDUCTION, PERSISTENCE, AND RECOVERY OF RADIATION DAMAGE IN PROLIFERATIVE (ANAGEN) AND NON-PROLIFERATIVE (TELOGEN) RODENT HAIR CELL POPULATIONS. Malkinson, F. D.; Griem, M. L. ([Univ. of Chicago]. Argonne Cancer Research Hospital, Chicago). pp 1099-1101 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.

See CONF-670719-(Vol.2).

The effect of x radiation on the incorporation of tritium-labeled serine by actively growing hair of mice was studied. Results are presented in tabular form. In general, it was observed that the anagen hairs were more radiosensitive (two-fold) than the telogen hairs. It was concluded that the establishment of radiation-induced, dose-dependent changes in the incorporation of serine into hair provides a simple, non-destructive in vivo method for evaluating a number of diverse radiobiological phenomena. (C.O.)

**29761** THE ACTION SPECTRUM OF ERYTHEMA INDUCED BY ULTRAVIOLET RADIATION. PRELIMINARY REPORT. Berger, D.; Urbach, F.; Davies, R. E. (Temple Univ. School of Medicine, Philadelphia). pp 1112-17 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.

See CONF-670719-(Vol.2).

A high-intensity spectral instrument with excellent stray light characteristics was designed and assembled. Performance characteristics of this high intensity double monochromator are given. Preliminary results of action spectra studies are presented. Subjects, ranging in age from 22 to 46 years, were irradiated with carefully measured doses of uv radiation. Erythema measurements were made at 4, 8, 24, and 48 hr. It was concluded that direct summation of the biologic effects of various wavelengths of uv radiation is not appropriate. (C.O.)

**29762** BIOLOGICAL DEPTH DOSE STUDIES IN ELECTRON BEAM THERAPY: EFFECTS ON ANAGEN MOUSE HAIRS. Lanzl, L. H.; Malkinson, F. D. ([Univ. of Chicago]. Argonne Cancer Research Hospital, Chicago). pp 796-8 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.

See CONF-670719-(Vol.2).

The skin-sparing effects observed when high-energy electrons are used for radiotherapy of cancer were investigated. Covered Teflon discs containing LiF crystals were used to determine the radiation dose to plucked flanks of female mice. Forty-eight hours after irradiation (14th day of anagen) all mice were given 3 to 5 μCi of tritium-labeled DL-serine intravenously. On the 24th day hairs from both flanks of each mouse were plucked for study. Low-dose exposure (300 Rads) depressed serine uptake in hair almost equally at entry and exit portals. At moderate doses of 500 to 600 Rads, reduced incorporation of serine at the beam entry site was further lowered by 15% on the average at the exit portal. It was concluded that even though the LET could not be expected to be identical at the surface as compared with the depth, this difference had not produced a significantly different RBE at the two positions for the biological indicator used. (C.O.)

**29763** PRODUCTION OF MELANOMAS IN HAIRLESS MICE WITH ULTRAVIOLET LIGHT. Epstein, J. H.; Epstein, W. L.; Nakai, T. (Univ. of California School of Medicine, San Francisco. Chicago Medical School). pp 939-40 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.

See CONF-670719-(Vol.2).

The development patterns of uv-induced benign melanomas in the skin of hairless mice were studied. The results of histological and electron micrograph studies are described and discussed. (C.O.)

**29764** ALTERATION OF A SMALL-INTESTINE MECHANORECEPTOR RESPONSE BY BETA RADIATION. Talbott, R. E.; Jones, D. C.; Kimeldorf, D. J. (Naval Radiological Defense Lab., San Francisco). Contract AT(49-7)-3004. Exp. Neurol., 23: 366-77(Mar. 1969).

Further evidence was obtained for a visceral receptor system that may serve to signal the presence of radiation to an animal. Because of the small-intestine movement receptor's superficial location in the serosal wall of the intestine, and by use of a small, low-penetration radiation source, irradiation of the receptor sites without appreciable exposure of other structures could be obtained. Responses of 37 receptors located at the serosal surface of the small intestine were obtained from anesthetized cats. None of these receptors exhibited spontaneous activity. None of the 21

irradiated receptors, each receiving about 0.5 rad/sec from a 25-mCi $^{90}Sr/^{90}Y$ $\beta$ source, exhibited neural activity as a consequence of irradiation alone. Post-stimulus-time histograms (PSTH) revealed characteristic patterns of neural activity upon mechanical stimulation. Quantitative comparison of the PSTH for 6 irradiated and 6 nonirradiated receptors that remained viable for at least five periods of mechanical stimulation revealed radiation-induced sustained decreases (3 receptors) or sustained increase (1 receptor) in total spike activity. These sustained alterations in response to mechanical stimulation were not seen in any of the 6 control receptors. These alterations were all developed during the first of two 100-rad exposures. The second dose did not affect the magnitude of the altered response, indicating that there was no cumulative dose effect on these receptors with doses <200 rad. The stable latency of the first spikes induced by mechanical stimulation of these receptors became more variable after irradiation. It appears that radiation can affect the level of response to an experimental analog of normal adequate stimulus, but that radiation does not induce neural activity in a quiescent small intestine mechanoreceptor. (BBB)

**29765** MYOCARDIAL CHANGES IN RABBITS FOLLOWING THEIR CHRONIC WHOLE-BODY IRRADIATION (CARYOMETRIC DATA). Vorob'ev, E. I.; Stepanov, R. P. Kosm. Biol. Med., 3: No. 2, 3-9(Mar.-Apr. 1969). (In Russian).

The effect of a chronic exposure of rabbits to ionizing radiation on their myocardium was examined. The animals underwent a whole-body irradiation with a dose of 20 r/day, receiving a total dose of 500, 1500 and 2400 R. The tissue changes were assayed using histological and caryometric techniques. On the 10th day after irradiation with any of the doses a decrease of the size of muscular nuclei against the background of interstitial edema, vascular hyperemia and dystrophically changed muscular fibers was found. The decrease persisted for 3 to 6 months after the exposure. The development of myofibrosis in the myocardium was accompanied by the formation of muscular fibers with large and gigantic cells. This can be considered as a manifestation of compensation and repair processes in the myocardium. (auth)

**29766** OCCURRENCE OF BACTEREMIA IN DOMESTIC FOWL AFTER IRRADIATION WITH X-RAYS $LD_{50}$. Horakova, V.; Tomanek, J. (Research Inst. of Veterinary Medicine, Brno). Vet. Med. (Prague), 14: 129-36(Feb, 1969). (In Czech).

The occurrence of bacteremia in domestic fowl that had been irradiated with a $LD_{50}$ dose of x-rays was determined. In the experiment, which was carried out in three stages, 188 cocks and hens of the New Hampshire breed were used. From the killed birds bacterial germs were isolated on the 2nd–8th day after irradiation, and from the birds that had died also on the 2nd–8th day. Cultivation from birds killed on the first day and from birds that had died on the first two days was negative with the exception of one case of 28 examined birds. From these results it can be seen that the germs that penetrated into the blood circulation of the irradiated organism already on the second day severely complicated the irradiation sickness up to the eighth day and may have been the cause of the death of the irradiated organism. (auth)

**29767** HISTOLOGIC CHANGES IN RAT SKIN AFTER 13 MeV PROTON IRRADIATION. Prince, John E.; Hinkle, Donald K.; Casey, Harold W. (Aerospace Medicine, Brooks AFB, Texas). Aerosp. Med., 40: 504-8(May, 1969).

Six levels of 13 MeV proton radiation, 200–2500 rads, were given forty-six 350 g Sprague–Dawley rats. Animals were exposed by ferris-wheel rotation around a cylindrical source parallel to the vertebral column. Each animal was biopsied five times at regular intervals beginning one week post-irradiation and continuing for 19 weeks. Skin biopsies of the sixteenth week were evaluated in tissue culture. Acute changes were seen 1 to 3 weeks at 1300 rads or more. Chronic skin changes were most severe at the 2000 and 2500 rad levels and extended with decreasing severity to the 1300 rad group. In culture the biopsied skin from irradiated groups was less active in producing monolayers than skin biopsies from control rats. Subsequently, 26 of 34 irradiated rats developed skin neoplasms during a 21 month post-irradiation observation period. (auth)

**29768** EFFECTS OF X IRRADIATION OF IMMATURE HAMSTERS ON GROWTH AND DEVELOPMENT OF GONADS. Turbyfill, C. L.; Chang, M. C. (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). Anat. Rec., 163: 353-8(Mar. 1969).

Effects of x irradiation on the hamster were studied from birth to puberty, particularly as affecting growth and development of the ovary and testis. Newborn hamsters were irradiated with 300 R 1, 7, 14, 21, or 30 days after birth. At the age of 33 days the animals were sacrificed. Body weight, testicular weight, and development of seminiferous tubules were severely affected by irradiation on day 1. Ovarian weight and the number of oocytes were more affected by irradiation on day 7 or 14. Ovarian weight did not always reflect the number of oocytes present. The ovaries of animals irradiated on day 1 had the greatest number of oocytes present, but weighed less than the ovaries of those irradiated on day 30, because the effect on oocytes and on ovarian weight was expressed at different times. Weight of the testis was most affected after irradiation 1 day after birth. The testis became less sensitive as the age of animals increased but a relatively higher decrease in testis weight was seen in the hamsters at the age of 30 days. Tubules of animals irradiated on day 1 were devoid of germinal epithelium, whereas in the animals irradiated on day 7, 83% of the tubules were without germ cells. In animals irradiated on days 14, 21, or 30, spermatogonia were present in all tubules and these cells were present in increasing frequency as the age of animals at irradiation increased. A dose of 300 R on day 1 for the male and on day 7 for the female was sufficient to produce permanent sterility in the hamster. (BBB)

**29769** ROLE OF RADIATION IN THE ETIOLOGY OF LEUKEMIA. Upton, Arthur C. (Oak Ridge National Lab., Tenn.). pp 55-71 of Proceedings of the International Conference on Leukemia–Lymphoma, Ann Arbor, Michigan, October 9–13, 1967. Zarafonetis, Chris J. D. (ed.). Philadelphia, Lea and Febiger, 1968.

See CONF-671073.

Ionizing radiation is leukemogenic to man and to experimental animals of widely differing species. Susceptibility varies, however, with species, strain, age, and other host factors, for reasons still largely obscure. Of the species investigated to date, the mouse appears most susceptible. Not all forms of leukemia and lymphoma, however, are equally inducible even in the mouse, and some forms seen not to be inducible by irradiation at all; i.e., chronic lymphatic leukemia in man. All types of ionizing radiation, internal as well as external, are leukemogenic, but the relation between dose and leukemia incidence remains to be established precisely. Virtually the only quantitative dose incidence experiments have been performed with mice, in which the incidence induced by a given dose has been found to depend markedly on the conditions of exposure. These experiments also imply that radiation may act through several mechanisms, one of which involves the release or "activation" of latent leukemia virus. The extent to which this mechanism is generally responsible for leukemias remains to be determined. Radiation effects of other types are postulated to contribute to the initiation, promotion, and progression of leukemias and lymphomas, the mechanisms conceivably varying, depending on the circumstances of irradiation and on the constitution of the population at risk. (146 references) (C.O)

**29770** DAMAGE TO THE ENDOTHELIUM OF THE BLOOD VESSELS BY IONIZING RADIATION. Ivanov, Yu. V. (Inst. of Biophysics, Moscow). Radiobiologiya, 9: 310-12(1969). (In Russian).

The radiation vulnerability of the endothelium of the blood vessels of rabbits was investigated by means of the level of chromosome aberrations. Aberrant mitoses were counted on a definite portion of abdominal aorta. The low proliferative activity of the endothelium was stimulated by its traumatization. The level of aberrant mitoses in the zone of the trauma in preliminary irradiated (500 R) animals reaches 48.6%. The results obtained indicate that the radiation vulnerability of the endothelium with respect to the criterion studied has no special features in comparison with other tissues of the organism. (auth)

**29771** COMPENSATION OF RADIATION DAMAGES TO THE EMBRYONIC BRAIN. Semagin, V. N. (Inst. of Higher Nervous Activity and Neurophysiology, Moscow). Radiobiologiya, 9: 204-8(1969). (In Russian).

Rat embryos of the Wistar line were irradiated at a dose of 1 R on the 18th day of embryogenesis under conditions of shielding of the mother's body. The higher nervous activity of the rats was investigated at an age of 8 to 16 months. The optical analyzer was affected to a greater degree than the auditory analyzer. Changes in the strength of excitation and inhibition, as well as the lability of the process of inhibition, arising as a result of irradiation of the embryonic brain, can be detected at one year of age. A specific feature of radiation damage to the embryonic brain is its noncompensability. (auth)

**29772** CHANGE IN THE NUMBER OF EPITHELIAL CELLS ON THE VILLI OF THE SMALL INTESTINES OF IRRADIATED MICE. Kononenko, A. M.; Farafonov, G. V. (Central Scientific Research Roentgenoradiological Inst., Leningrad). Radiobiologiya, 9: 209-12(1969). (In Russian).

The change in the number of epithelial cells on the villi of the small intestines of mice during a three-day period after irradia-

tion at doses of 700 and 900 R was determined. The wave-like change in the number of epithelial cells on sections of irradiated villus, agreeing with the wave-like variation of the mass of the crypt, confirms the hypothesis that the movement of cells from the crypt to the villus is caused primarily by physical pressure, determined by the amount of matter contained in the crypt. The anomalous growth of proliferative cells of the irradiated intestinal epithelium, deprived of their reproductive ability, promotes this movement and devastation of the cellular population of the crypts. (auth)

**29773** INFLUENCE OF SEPARATE AND COMBINED USE OF 5-METHOXYTRYPTAMINE AND CYSTAPHOS ON THE FORMATION OF ENDOGENOUS COLONIES OF HEMATOGENIC TISSUE IN THE SPLEENS OF IRRADIATED MICE. Zaitseva, K. K.; Zherebchenko, P. G.; Zaitseva, T. G. (Military Medical Academy, Leningrad). Radiobiologiya, 9: 236-41(1969). (In Russian).

The influence of separate and combined use of 5-methoxytryptamine (5-MOT) and cystaphos (CP) on the number, magnitude, and cellular composition of endogenous colonies of hematogenic tissue formed in the spleens of mice of the CC57W line, as well as the weight of the spleens on the 10th day after γ-irradiation at a dose of 750 R, was studied. In number of endogenous colonies formed and weight of the spleens, the radioprotective activity of CP is more pronounced than that of 5-MOT. Under conditions of combined use of the preparations, the number of endogenous colonies of hematogenic tissue in the spleens of the irradiated mice was correspondingly 4.7 and 1.7 times higher than in the case of separate administration of 5-MOT and CP. The endogenous colonies most frequently consisted of erythroid cells. Practically no nodes with a granulocytic type of cells were detected. In the case of combined protection, a statistically significant increase in the number of colonies with a mixed cellular composition is observed, with a tendency for a relative decrease in the number of colonies consisting of erythroid and undifferentiated cells. In this case an increase in the area of the lymphoid follicles is detected, with the appearance of substantial-sized centers of multiplication. (auth)

**29774** INFLUENCE OF RADIOPROTECTORS ON THE EARLY RADIATION RESPONSE OF THE PITUITARY–ADRENAL SYSTEM. Borisova, L. Ya. (Central Roentgenoradiological Scientific Research Inst., Leningrad). Radiobiologiya, 9: 246-8 (1969). (In Russian).

In the irradiation of noninbred white rats at a dose of 650 R, an increase in the corticosterone level in the peripheral blood was detected in the early periods after irradiation, with a maximum after 2.5 hrs. The radioprotectors (cystaphos, mexamine, AET) also produce an increase in the level of corticosterone in the peripheral blood 10 min after administration. The greatest stimulating effect on the adrenal cortex was exhibited by mexamine. The corticosterone level was lower 2.5 hrs after irradiation with cystaphos protection than after irradiation without protection and after the administration of the protector itself. (auth)

**29775** UTILIZATION OF CYTOLOGICAL ANALYSIS OF CELLS OF WHITE BLOOD UPON THE STUDY OF INFLUENCE OF SMALL DOSES OF URANIUM ON ANIMAL ORGANISM. Rodionova, L. F. (Leningrad Scientific-Research Inst.). Gig. Sanit., 33: 64-6(Dec. 1968). (In Russian).

The cytological analysis of peripheral blood cells is justified in the study of the effects of harmful factors of small intensity on an organism. The frequency of occurrence of atypical white blood cells in rats was inconsistent following the prolonged receipt by mouth of uranyl nitrate in doses of $1.88 \times 10^{-4}$ g/g (of uranium). Therefore, the significance to the organism is improbable. (MTOR)

**29776** RADIATION NEPHRITIS. ACUTE CHANGES FOLLOWING HIGH DOSE OF RADIATION. Madrazo, A.; Suzuki, Y.; Churg, J. (Barnert Memorial Hospital Center, Paterson, N. J. Mount Sinai School of Medicine, New York. St. Vincent's Hospital and Medical Center, New York). Amer. J. Pathol., 54: 507-27(Mar. 1969).

Male Sprague-Dawley rats were used to study the effects of high doses of radiation on the kidneys. After exposing the left kidney, 4800 and 9600 rads of x radiation were given in a single dose. Animals were studied by light and electron microscopy from 30 min to 30 days after irradiation. Marked glomerular lesions were found in 4 to 6 days and consisted of extensive fusion of foot processes, degenerative changes of epithelial cells, marked tortuosity of glomerular basement membranes, and rarefaction and increase in the mesangial matrix. There was extensive tubular atrophy and necrosis, marked thickening and tortuosity of the tubular basement membranes, and an increase in the subcellular space. Interstitial edema, numerous acute and chronic inflammatory cells, and fibrosis were also present. The interstitial capillaries showed no significant changes. These observations suggest a distinct glomerular reaction to high doses of radiation and point to the marked susceptibility of tubular cells, especially of the proximal convoluted tubules. The absence of interstitial vascular change is noteworthy. (auth)

**29777** CHANGES IN BRAIN SELF-STIMULATION RATES AFTER EXPOSURE TO X-IRRADIATION. Christensen, H. Dix; Flesher, A. M.; Haley, Thomas J. (Univ. of California, Los Angeles). Contract AT(04-1)-GEN-12. J. Pharm. Sci., 58: 128-9(Jan. 1969).

Alterations in the pressing rate of hypothalamic self-stimulating rats were observed after ionizing radiation. Total-body 600 R x irradiation increased, decreased, or had no effect on the mean pressing rate with generally little change in the daily rate deviation. While there was a correlation between structure and pressing rate, the agreement between irradiation response and hypothalamic structure was not complete. Electrodes in the median forebrain bundle produced no change in pressing rate after irradiation. Head irradiation mainly increased the daily deviation without changing the mean. The whole-body irradiation effects are probably not direct. (auth)

**29778** EFFECT OF MICROWAVES ON THE EYE. Birenbaum, Leo; Grosof, Gerard M.; Rosenthal, Saul W.; Zaret, Milton M. (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Bio-Med. Eng., BME-16: 7-14(Jan. 1969).

Acute effect of microwave energy on the eyes of rabbits was experimentally investigated using both CW (continuous wave) and pulsed power at 5.5 GHz. Lens opacities developed within four days after exposures of sufficient intensity and duration. Three min at the 1-W level were found to exceed the cataractogenic threshold, while at the ½-W level no acute effect was observed following a 2-hr exposure. The exposed eye served as the termination of a length of waveguide, permitting conventional microwave instrumentation to be used for measurement of power entering the eye. A device to channel the microwave power from the relatively large waveguide cross section through a small aperture for delivery into the eye of the animal was developed. Threshold curves for CW and pulsed (0.001 duty cycle) power showed no substantial difference. Thus, the average power level rather than the peak power was the determinant of injury. The exposure technique described serves as a useful tool for inducing cataracts. (BBB)

**29779** RESPONSE OF SAIMIRI SCIUREUS MONKEYS TO TOTAL BODY X-IRRADIATION: ELECTRON MICROSCOPIC CHANGES IN THE LIVER. Carstens, L. A.; Allen, J. R. (Univ. of Wisconsin, Madison). Amer. J. Vet. Res., 30: 623-35(Apr. 1969).

Saimiri sciureus monkeys were given 800 R of whole body x irradiation. At the time the monkeys died, their livers were examined by electron microscopy. There were focal areas of hemorrhage, necrosis, and bacteria throughout the liver. In the necrotic areas, many cells were swollen and electron lucent, whereas others were shrunken and electron dense. These cells underwent fragmentation and lysis. A majority of the hepatocytes were very active metabolically, as indicated by their size and by arrangement, distribution, and number of their cytoplasmic organelles. (auth)

**29780** IN VITRO BIOSYNTHESIS OF ANDROGENS BY X-IRRADIATED TESTES. Inano, Hiroshi; Tamaoki, Bunichi (National Inst. of Radiological Sciences, Chiba, Japan). Endocrinol. Jap., 15: 197-207(June 1968).

After x irradiation, the testicular weight of mice (6 weeks in age) decreased gradually, being significantly reduced on the 14th day post-irradiation and thereafter, in comparison to the control group. The specific activity of the 17α-hydroxylase in testicular homogenates of the x irradiated mice became higher than in non-irradiated animals. When testes of the rats were locally x irradiated, the weight of testes decreased almost half, but the weight of accessory organs remained almost unchanged. However, further detailed analysis of the individual enzymes of rats related to biosynthesis of androgens revealed that the 17α-hydroxylase and the 17α-hydroxypregnene $C_{17}-C_{20}$ lyase activities per testis were significantly reduced by local x irradiation, while the $\Delta^5-3\beta$-hydroxysteroid dehydrogenase activity coupled with the isomerase was somewhat enhanced by this treatment. By administration of human chorionic gonadotrophin to the locally x irradiated rats, the enzyme activities related to testosterone formation, except 17β-hydroxysteroid dehydrogenase, were stimulated, in accordance with the increased weight of accessory organs. From the observation that the specific activities of the enzymes related to androgen production were higher in x irradiated animals than in the controls, and that those activities were stimulated by the gonadotrophin, in parallel with histological observations on proliferation of interstitial cells, it was concluded that the enzymes related to testosterone production from pregnenolone were located in the microsomes of interstitial cells. (NSA of Japan) (TSS)

**29781** CHANGES IN INCORPORATION OF $^{3}H$-THYMIDINE INTO HEMATOPOIETIC CELLS OF GOLDFISH FOLLOWING X-IRRADIATION. Etoh, Hisami (National Inst. of Radiological Science, Chiba, Japan). Dobutsugaku Zasshi, 77: 213-19 (July 1968). (In Japanese).

It has been reported that hematopoietic failure is responsible for the radiation death in fish as in mammals. A series of experiments, designed to clarify the cell population kinetics of hemopoiesis in irradiated and non-irradiated goldfish were carried out. Casassius auratus were kept in water at 25, 15, or 6°C, and then irradiated with 1 or 8 kR of x rays. Tritium-labeled thymidine (10 or 15 μCi) was injected intraperitoneally into each fish after irradiation. Fish were sacrificed at various intervals after the injection. Smear preparations of the hematopoietic tissue and the peripheral blood were fixed with methyl alcohol and coated with nuclear track emulsion by dipping the method for autoradiograph. In comparison of hematopoietic cell kinetics in fish kept at 25 and 15°C, the former was three to five times more rapid than the latter. No marked inhibition of DNA synthesis was found immediately after lethal irradiation (8 kR) under the present experimental conditions, whereas proliferation of hematopoietic cells was completely inhibited. The rate of disappearance of labeled cells from hematopoietic tissue was slower in a cool environment. Following x irradiation of 1 kR proliferation of the labeled cells was delayed and cell death occurred. These results show that hematopoietic processes in fish are observable by autoradiography with $^{3}H$-thymidine and the rate of development of radiation injury in the hematopoietic tissue is slowed down at lower temperature. (NSA of Japan)

**29782** CHANGES IN ANTIBACTERIAL AND PROTEOLYTIC ACTIVITY OF POLYMORPHONUCLEAR LEUCOCYTES FOLLOWING THE WHOLE-BODY X IRRADIATION OF RABBITS. Stefanovic, J.; Kison, S.; Absolonova, O. (Comenius Univ., Bratislava). Folia Microbiol. (Prague), 13: 424-31 (Oct, 1968).

After whole-body x irradiation of rabbits with 150, 500, and 1000 R, the antibacterial and proteolytic activity in extracts of polymorphonuclear leucocytes obtained from peritoneal exudate was tested immediately at one, three, six, 10, and 21 days following irradiation. The changes in antibacterial activity tested in Escherichia coli, Bethesda, and Salmonella adelaide strains depended on the radiation dose and on the interval between irradiation and collection of leucocytes. With increasing radiation doses the antibacterial activity in Bethesda and S. adelaide strains was decreased. In rabbits irradiated with 150 and 500 R a decrease or even a disappearance of bactericidal activity on the sixth day in all strains tested was found, whereas after irradiation with 1000 R the antibacterial activity was low immediately after irradiation and this decrease could be detected up to the tenth day. Using E. coli strains the antibacterial activity of leucocyte extracts did not show such a regular dependence on the dose of radiation and time as with other strains. The proteolytic activity of leucocyte extracts tested at pH 3.5 (cathepsin D and E) and pH 2.0 (cathepsin E) within three days after irradiation was higher with increasing doses. At other time intervals the activity did not show regular changes. (BBB)

**29783** THE RELATION BETWEEN WEIGHT LOSS AND LENGTH OF SURVIVAL IN IRRADIATED MICE (SINGLE WHOLE-BODY IRRADIATION WITH 700 OR 800 RAD). A CONTRIBUTION TO METHODOLOGY OF EVALUATION OF RADIOBIOLOGICAL EXPERIMENTS. Schwarzenbach, F. H. (Zuercher Hochgebirgsklinik, Davos-Clavadel, Switzerland). Vierteljahresschr. Naturforsch. Ges. Zuerich, 113: 291-303 (Sept. 1968). (In German).

Weight loss and survival times were measured in mice x irradiated with a whole-body dose of 700 to 800 R. Daily wt loss after irradiation was not affected by feeding of a specially prepared diet, although finally there was an average total wt loss of about 1 g. After irradiation with a dose of 800 R there was no difference in wt loss. The length of survival after irradiation with a dose of 700 R was shortened by one day in the animals fed the prepared diet, and the average wt loss was about 1 g. There was no clear effect of the diet on survival of the animals that received a dose of 800 R. There was some evidence that wt loss should be more definitely considered in the evaluation of the effects of radioprotective agents on survival after x irradiation. (BBB)

**29784** CHANGE OF THE HALF-LIFE OF SURVIVAL OF IN VIVO $^{51}Cr$ LABELED ERYTHROCYTES OF THE RAT AFTER WHOLE-BODY IRRADIATION. Dienstbier, Z.; Kocandrle, K.; Prouza, Z.; Pospisil, J. Cas. Lek. Cesk., 107: 649-52 (May 31, 1968). (In Czech).

Changes in survival of erythrocytes in the rat after whole-body irradiation with an x-ray dose of 600R were assessed. The radioisotope diagnostic method of direct assessment of the half-life of survival of erythrocytes with in vivo labeling with $^{51}Cr$ was used. The half-life of survival of red blood cells in irradiated rats was 7.5 days, while in controls it was 20.4 days. By investigating the incorporated activity in the spleen, liver, and kidneys a relation was revealed between the half-life of survival of erythrocytes and the increase of incorporated activity in the spleen in both groups. (auth)

**29785** STATE OF THYROID GLAND AND ANTITUMOR RESISTANCE OF RATS INJECTED WITH A MINIMAL BLASTOMOGENIC DOSE OF $^{90}Sr$. Berezovskii, B. S. (Veterinary Inst., Kazan). Vop. Onkol., 15: No. 3, 66-71 (1969). (In Russian).

In single intraperitoneal injection of 0.05 μCi/g of $^{90}Sr$ in white rats during subsequent 30 weeks there occurred changes in antitumor resistance to transplantable ascitic Zeidel hepatoma and ovarian tumors, and in the thyroid function. Antitumor resistance was enhanced during 12 weeks since the onset of the lesion and reduced following 16 weeks. The thyroid function was reduced during the first 8 weeks and enhanced starting from 18 to 30 weeks of the affection. Presumably, phase changes both in the thyroid function and antitumor activity in application of $^{90}Sr$ are related to alterations in the balance of rival interrelations of the hypophyseal tropic functions. (auth)

**29786** EFFECT OF GAMMA-RADIATION ON INDUCTION OF TUMORS WITH ULTRA-VIOLET RAYS. Sviderskaya, T. A.; Aleksandrov, S. N.; Gubareva, A. V. (Research Radiation Hygiene Inst., Leningrad. Central Research Roentgeno-Radiological Inst., Leningrad). Vop. Onkol., 15: No. 3, 83-7 (1969). (In Russian).

Experiments on 147 mice demonstrated that uv irradiation in massive doses was accompanied by considerable blastomogenic effect. Preliminary γ irradiation in small doses increased the incidence of malignant neoplasms and reduced the latent period of their development. (auth)

**29787** ROLE OF HOST FACTORS IN INDUCTION OF LEUKEMIA BY RADIATION AND VIRUS. Yokoro, Kenjiro; Ito, Takaaki (Hiroshima Univ.). Acta Pathol. Jap., 18: 362-71 (Aug. 1968).

Ten week-old male RF/Jax mice were given a single whole-body x radiation dose of 300 R. Some mice were inoculated intraperitoneally with the Gross virus (passage A virus) within a few hrs after irradiation. Similar treatment was given to mice thymectomized at four weeks of age. The leukemogenicity of the Gross virus in adult RF/Jax mice was low, inducing thymic lymphomas and nonthymic lymphomas in 11.3 and 4.1% of mice, respectively, and no myeloid leukemia occurred. Irradiation induced myeloid leukemia in 10.4% and thymic lymphoma in 30.2% of mice. In irradiated-virus-infected mice, although the occurrence of thymic lymphoma was not appreciably influenced, the incidence of myeloid leukemia was more than tripled by the virus infection. Thymectomy was effective in enhancing the development of myeloid leukemia, while thymic lymphoma was completely inhibited in irradiated mice. In other experiments in ICR/JCL mice, various combinations of thymectomy, $^{90}Sr$ injections (1.0 μCi/g intraperitoneally), whole-body x irradiation (four doses of 170 R at five day intervals), and 1000-R hind-limb x irradiation were used to induce leukemia. The highest leukemia incidence was observed in whole-body irradiated mice and it was markedly suppressed by thymectomy (77.3% to 20.8%). Administration of $^{90}Sr$ was also highly leukemogenic in this strain of mice. Thymectomy enhanced the leukemogenicity of $^{90}Sr$ from 55.9% to 67.6%, which was a sharp contrast to results in x-irradiated mice. Partial-body x irradiation showed a slight additive effect to the leukemogenicity of $^{90}Sr$. Most of the leukemias developed between three to seven months after the treatments with exceptions in thymectomized-x-irradiated and partial body x-irradiated groups in which incubation time was prolonged. As to the type of leukemia induced, most x-irradiated mice developed the lymphoblastic type originating in the thymus, while many of $^{90}Sr$-treated mice had nonthymic lymphomas of various cell types. Reticulum cell type was often observed in thymectomized-$^{90}Sr$-treated mice. No myeloid leukemia developed in any group. Some osteogenic sarcomas occurred in $^{90}Sr$-treated mice, with a much longer incubation than that of leukemia. Response of the hematopoietic tissue to $^{90}Sr$ and x irradiation is also described. Two cases of leukemia, one from $^{90}Sr$-induced and one from x-ray-induced disease, were transmissible with cell-free materials up to three successive animal passages. It is suggested that radiation may act as a trigger for leukemogenesis by providing a state of the target cells favorable for virus multiplication. (BBB)

**29788** X RAYS AND THE MONKEY FETAL RETINA. Rugh, Roberts; Skaredoff, Ludmilla (Columbia Univ., New York). Invest. Ophthalmol., 8: 31-40 (Feb, 1969).

Two male monkeys were irradiated in utero at two different gestational ages and at two levels of exposure. One was given 300 R at 60 days and the other 200 R at 80 days of gestation.

These two and the one control monkey studied were born within a month of each other and were examined up to 23 months of age to determine the effects of x rays on the developing retina. In general, the response agreed with prior studies on all other vertebrates, so that rodent findings are applicable to primates. The time at which the developing retina was exposed to radiation determined what part of the retina was damaged. Structural damage to the differentiating retina (the neuroblasts) was irrevocable and irreparable; eyes of the monkey irradiated at 60 days showed persistence of the damage as severe nuclear deficits and rosette formation. No proliferation of retinal cells or nuclei following x radiation damage to the neuroblasts and their removal by phagocytes occurred. Thus, when susceptible (differentiating) cells are traumatized by x rays, they are removed and the remaining cells (if any) attempt to reconstitute the retina. The visual function of the monkey eye was quantitatively reduced by fetal x radiation at 60 days' gestation as indicated by electroretinographic recordings. Neuroblasts appeared to be particularly radiosensitive and even cortical neuroblasts were affected by x rays. It is recommended that after the human embryo or fetus is exposed to ionizing radiations in excess of 10 R during the first trimester there be a therapeutic abortion. (BBB)

**29789** RESPIRATORY CAPACITY AT REST AND DURING PHAGOCYTOSIS OF THE GRANULOCYTES FROM PERITONEAL EXUDATES OF RATS SUBJECTED TO INTERNAL IRRADIATION WITH $^{32}P$. Turcou, Gr.; Albu, A. St. (Medical-Pharmaceutical Inst., Bucharest). Arch. Roum. Pathol. Exp. Microbiol., 26: 353-60(June 1967).

Respiration of phagocytic cells of irradiated animals was studied using the polymorphonuclear leucocytes (PMN) in sterile peritoneal exudates obtained from rats injected with $Na_2H^{32}PO_4$ at a dose of 1 $\mu$Ci/g. Determinations were carried out in a Warburg microrespirometer after incubation of the leucocytes in the medium described by Beck et al. The cells were collected at various intervals (3, 12, and 20 days) chosen according to various parameters determined by the results of a previous investigation. The results of the present experiments revealed that the $O_2$ consumption of PMN collected on the 3rd, 12th, and 20th day of internal irradiation was not significantly different from that in controls. On the other hand, the respiratory capacity of PMN during phagocytosis was definitely increased on the 3rd day of internal irradiation and progressively decreased on the 12th and 20th day, the differences being statistically significant. (BBB)

**29790** ANIMAL EXPERIMENTS CONCERNING RADIATION BURDENS DUE TO THORON CONTENT OF AIR. Plattner, Helmut (Univ. of Innsbruck). Strahlentherapie, 136: 750-7 (Dec. 1968). (In German).

Animals were forced to inhale Tn (+ThA) without their longlived daughter products. Tn enters the blood through the lungs, where the disintegration begins. These products can be demonstrated in the respiratory tract, from where they can enter the blood or be transferred through the upper respiratory tract to the intestinal tract. These products can be isolated by ligation of the esophagus. The ThB, resorbed from the intestine is deposited mainly in bone in the kidneys. The ThB and ThC can be found as isotopes of Pb and Bi according to their respective biochemical affinities. ThC is found mainly in plasma, urine, bile and in the kidneys, ThB in bone and liver. The elimination of these products is low. For the first time evaluations are made, based on experimental studies, of the absorbed dose in human tissues, from atmospheric Tn. (auth)

**29791** INVESTIGATIONS ABOUT COMBINATION INJURIES. 11. CHANGES IN THE INCIDENCE OF MITOSIS IN THE SPLEEN OF MICE AFTER WHOLE-BODY IRRADIATION COMBINED WITH SKIN WOUNDS. Chaudhuri, Jyoti P.; Messerschmidt, Otfried (Univ., Freiburg i. B.). Strahlentherapie, 136: 733-7(Dec. 1968). (In German).

Earlier studies in rats and mice showed that combined lesions (irradiation and skin wounds) provoked an earlier recuperation of red and white cells, than after an irradiation alone and with the same dose. In this work the authors look for possible difference in the spleen colony formation. They observed that combined lesions resulted in a higher mitotic activity than irradiation alone. (auth)

**29792** ON THE DEGENERATION AND REGENERATION OF NERVES OF THE SKIN IN THE PROCESS OF HEALING OF CUT WOUNDS IN ACUTE RADIATION SICKNESS. Serdyukov, G. I. Vrach. Delo., No. 2, 67-70(Feb. 1968). (In Russian).

Experiments conducted on dogs showed marked degenerative changes of the peripheric nervous system in the region of a linear incised wound of the skin produced at different stages of acute radiation syndrome, caused by total irradiation of the animal (300 R). Despite significant lesions of the peripheric nervous system caused by irradiation its elements showed high regenerative properties. (auth)

**29793** RENAL PATHOMORPHOLOGY IN EXPERIMENTAL RADIATION SICKNESS IN RABBITS. Szczurek, Zbigniew; Habczynska, Danuta (Academy of Medicine, Katowice, Poland). Med. Pracy, 18: 646-50(1967). (In Polish).

Histologic studies were made of the kidneys of rabbits exposed to x-ray doses of 200, 500, 700, and 1000 R and examined 1 to 33 days later. The main finding in the kidneys consisted of reversible inflammation which was more severe after the higher doses of radiation. The changes seen in the kidney appeared to originate in the epithelial cells of the convoluted tubules, then progressed to affect the blood vessels and lead to circulatory disturbances. The functional disorders seen in the kidneys of irradiated patients are interpreted in light of the renal changes observed here in irradiated rabbits. (BBB)

**29794** THE INFLUENCE OF IRRADIATION ON THE FREQUENCY AND RATE OF APPEARANCE OF BREAST TUMORS IN RATS. Moskalev, Yu. I.; Petrovich, I. K.; Streltsova, V. N. Byull. Eksp. Biol. Med., 67: No. 4, 95-9(Apr. 1969). (In Russian).

Irradiation of rats with x rays and gamma rays in doses of 100 or 300 R in single or fractional doses shows that fractionation does not influence the frequency and rate of the growth of breast tumors or the peripheral blood composition. Fractionation of a 600 R dose, which in a single dose produced acute radiation sickness and rapid and early death of a considerable number of animals, increased the survival of animals markedly. (C.O.)

**29795** THE EFFECT OF FASTING ON NERVE REGENERATION IN COMBINED INJURIES. Nechai, E. E. Vrach. Delo., No. 2, 70-4(Feb. 1968). (In Russian).

Clinical and pathohistological investigation on 88 rabbits subjected to neurotomy with subsequent neurorrhaphy indicate that absolute starvation during the first day following total irradiation significantly worsens the course of radiation sickness and retards the regenerative processes in the injured nerve. Parenteral administration of ascorbic acid, thiamine, pyridoxine to animals in conditions of this experimental model of combined radiation lesion favorably affects the clinical course of radiation syndrome and furthers reparative nerve regeneration. (auth)

**29796** THE REACTION OF THE NEUROSECRETORY HYPOTHALAMO-HYPOPHYSEAL COMPLEX IN THE GUINEA PIG FOLLOWING X IRRADIATION (200 KV). Biernat, B.; Lierse, W.; Franke, H. D. (Univ., Hamburg). Z. Zellforsch. Mikroskop. Anat., 90: 447-53(Aug. 26, 1968). (In German).

The effect of 200 kV x irradiation on the hypothalamus and hypophysis of male and female guinea pigs was examined 24, 72, 120, and 240 hr after irradiation of the head. Doses of 500, 1000, 2000, and 3000 R were used at 100 R/min. At 24 hr following irradiation at all doses, a decrease of neurosecretory material occurred in the nucleus supraopticus, nucleus paraventricularis, and in neurohypophysis. At 72 hr following irradiation with 500 R, the amount of neurosecretory material increased and normal levels were attained at 10 days. Higher doses (1000 to 3000 R) prevented the increase that was observed with 500 R at 72 hr, and the animals died after 1 week. (BBB)

**29797** LATER RADIATION INDUCED CHANGES IN THYROIDS OF $^{125}I$ TREATED RATS. Konecny, Milan (Univ., Brno). Atomkernenergie, 14: 211-13(May-June 1969).

Statistically significant increase of the weight of the 1,125 irradiated rat thyroids has been observed on the 45th, 75th, and the 90th day of the experiment. Beginning with the 105th day the weight of thyroids decreased, and became insignificant. The decay of the activity of the thyroids shows an abrupt break at the 8th day, as a sign of cellular destruction. Beginning with the 75th day the decay curve became flat. The histological findings show first signs of thyroid impairment between the 8th and 15th day, with a maximum at the 75th day of the experiment. From the 105th day the histological picture shows reparative processes in the follicular epithelium. Functional changes are suggested in the impairment of enzymatic systems of the follicular cells. (auth)

**29798** EFFECT OF X RAYS ON THE HEALING COURSE OF ORAL MUCOSA. Piekos, Boleslaw (II Dzielnicowa Przychodnia Obwodowa, Krakow). Przegl. Lek., 23: 535-7(June 1967). (In Polish).

Studies were conducted in 22 golden hamsters, with 12 animals in the experimental and 10 in the control group. The first group received a single dose of 660 R whole-body x irradiation. Within 3 to 10 hr after irradiation, oral mucosa, and superficial skin of hamsters' cheeks were incised and then sutured. The control group was not exposed to irradiation, but subjected to identical cheek wounds. Both groups subsequently received the same dose (25,000 units) of penicillin/day for 4 days. The first symptoms of radiation sickness appeared 2 days after irradiation in the form of

sluggish behavior, loss of appetite and weight, and loss of hair on the back. Blood blisters in the nasal cavity appeared on the 8th day. The incision in irradiated hamsters was covered with yellowish scab after the 5th day and surrounding tissues showed blood extravasation. Healing of the incision in irradiated hamsters lasted 10 to 11 days, compared to 3 to 4 days in nonirradiated animals. Wounds opened in 4 hamsters due to necrosis of surrounding tissues, 4 hamsters died of radiation sickness on the 8th day, and 3 animals lost their eyesight. Histopathological examinations of the incised mucosa revealed foci of deep incrustations containing polymorphonuclear leukocytes under the skin. (BBB)

**29799** CHANGES IN RAT HEARTS FOLLOWING SELECTIVE X-RAY IRRADIATION. Morgenroth, K. Jr.; Junge-Huelsing, G. (Univ., Muenster, Ger.). Verh. Deut. Ges. Pathol., 51: 147-50(1967). (In German).

Electron microscopic studies were done in hearts of rats after x irradiation with a focal dose of about 3000 R. Investigations done at different time intervals showed significant changes in the capillaries of the heart muscle. The formation of shoots and loops as well as swelling of the capillary endothelium result in a constriction of the width of the vessels. In the heart muscle cells, vacuoles in the mitochondria, and a dilatation of the sarcoplasma reticulum are found in later stages after irradiation. Big spaces are formed in the cells which are free of formed substances and show only a granular content. It is not clear, whether those changes are the result of a direct radiation influence upon the heart muscle cells or caused secondarily by damage to the capillaries. Since the capillary damage with the swelling of the endothelium occurs prior to the changes in the heart muscle cells, it is assumed that this damage of the capillary endothelium causes primarily a disturbance in permeability and nutrition which is followed by necroses of the heart muscle cells. (auth)

**29800** THE ULTRASTRUCTURE OF VIRUS- AND RADIATION-INDUCED THYMOMAS OF C57BL MICE. Lagerloef, Bengt (Karolinska Institutet, Stockholm). Acta Pathol. Microbiol. Scand., 74: 495-513(1968).

Light and electron microscope studies were performed on the thymus of C57Bl/Ka mice bearing induced thymomas. For the induction of thymomas by irradiation treatment, the mice were subjected to 4 doses of 170 R of unfiltered $^{60}Co$ $\gamma$ irradiation separated by 7-day intervals. This treatment induced thymoma development in almost 100%, with death in 150–200 days. For induction of thymomas by virus treatment, weanling mice were thymectomized and exposed to 4 doses of whole-body irradiation as indicated above. One day after the last radiation exposure one thymic lobe from a newborn syngeneic donor of the same sex was implanted beneath the capsule of the left kidney. One week later 0.02 ml of a virus preparation was injected directly into the thymic implant. The ultrastructure of the tumor cells was generally very regular and similar to that of lymphoblasts from normal embryos. Occasional lysosomes could be observed in some tumor cells. The number of ribosomes was larger in lymphoblasts and tumor cells than in normal thymocytes from adult mice. Histological classification into highly and lowly differentiated tumors in electron micrographs was seen to correspond to less pronounced peripheral condensation of the chromatin in the nucleus of the lowly differentiated tumor cells, whereas no particular differences were evident in the cytoplasm. In 1 out of a total of 6 virus-induced thymomas, virus particles of C-type were observed in the cellular spaces and in the process of budding off from the cell membrane. In 1 radiation-induced thymoma, similar particles were observed between cells and in the cytoplasm. (BBB)

**29801** DEPRESSION OF GROWTH FOLLOWING RADIOTHYROIDECTOMY OF LARVAL CHINOOK SALMON AND STEELHEAD TROUT. Norris, David O. (Univ. of Colorado, Boulder). Trans. Amer. Fish. Soc., 98: 104-6(Jan. 1969).

The effect of a single dose of radioiodine and of an equivalent dose of external $\gamma$ radiation on the thyroid of fish was evaluated. This study was undertaken to ascertain whether or not thyroid hormones were involved in the regulation of growth during the first year of life for steelhead rainbow trout (Salmo gairdnerii) and chinook salmon (Oncorhynchus tshawytscha). Successful use of radioiodide to produce radiothyroidectomy in larval salmonids enhanced the preparation of large numbers of radiothyroidectomized larval fish. Comparison of percent increase in weight of control and experimental fish indicated a significant depression in rate of growth as early as 2 months following radioiodide treatment. No marked depression nor stimulation of growth rate occurred in the $\gamma$-irradiated fish as compared to normal fish. Head/body proportions were altered in radiothyroidectomized steelhead, but these proportions were not altered noticeably in chinook. Mortalities were calculated to be 25.5 and 69.0 for radiothyroidectomized, 14.4 and 37.7 for irradiated, and 16.0 and 46.5% for untreated trout and salmon, respectively. The higher mortality of radiothyroidectomized fish was not explained. (BBB)

**29802** THE CONCENTRATION OF COENZYME A IN PLACENTA AND FETAL AND MATERNAL RAT LIVERS IN CONTROLS AND AFTER WHOLE-BODY IRRADIATION WITH 800 R. Theil, S. (Friedrich-Schiller-Univ., Jena, Ger.). Wiss. Z. Friedrich-Schiller-Univ., Jena, Math.-Naturwiss. Reihe, 17: 67-9(Jan. 1968). (In German).

Concentrations of coenzyme A in fetal and maternal rat livers and in placenta did not increase significantly from normal following a single whole-body dose of 800 R of x irradiation given to pregnant rats. Based on organ fresh wt a slightly smaller amount was found in placenta. In unirradiated animals small differences were observed, depending on whether the coenzyme A was evaluated by thiokinase test or by acetylation of sulfonamide. Relations between coenzyme A concentrations and fatty acid synthesis in irradiated pregnant rats were discussed. In fetal liver and placenta the rate of incorporation of $^{14}C$-labeled acetate was not altered after x irradiation, but coenzyme A concentration in maternal liver was markedly decreased. It was concluded that this was due to inhibition of acetyl-coenzyme A-carboxylase by increased fatty acid mobilization and by fatty acid transport problems in the x-irradiated pregnant rats. (BBB)

**29803** DISRUPTION OF RADIATION-INDUCED AVERSION TO SACCHARIN DRINKING BY ELECTROCONVULSIVE SHOCK. Riege, Walter Hinrich. Athens, Ga., Univ. of Georgia, 1968. 59p.

Thesis.

Using the phenomenon of radioinduced aversion to saccharin solution in laboratory rats, this study tested the theoretical implication that the motivational shift followed the classical conditioning paradigm and involved sensory-cortical structures. It was hypothesized and found that the association between saccharin drinking by rats and their irradiation can be disrupted by the administration of a single electroconvulsive shock in some temporal proximity to the exposure period. In two related experiments it was observed that rats, trained in saccharin drinking, shifted their previously stable preferences for saccharin to an inclusion of water in their fluid intake after low-dose x irradiation, but failed to do so when given convulsive shock with exposure. The retrograde amnesia exerted by the shock treatment was even effective when backward or trace conditioning procedures were employed. Only the absolute saccharin consumption values reflected some influence of the irradiation. The results were taken to underline the hypothesis that radiation detection as well as radioinduced aversion rely on one and the same mediating mechanism in which central nervous system structures must be postulated to participate. (Diss. Abstr.)

**29804** THE USE OF LINOLEIC ACID AS A NONRADIOACTIVE TRACER IN THE STUDY OF RADIOINDUCED NEUTRAL FAT DEPOSITION IN RAT FETUSES. Winkler, L. (Friedrich-Schiller-Univ., Jena, Ger.). Wiss. Z. Friedrich-Schiller-Univ., Jena, Math.-Naturwiss. Reihe, 17: 70-1(Jan. 1968). (In German).

Deposition of neutral fat in fetal rat tissues was measured after a single whole-body dose of 800 R of x irradiation. Within 24 hr of irradiation the liver triglyceride fatty acids tripled, but the total neutral fat in the entire fetus peripheral neutral fatty acids increased only slightly. The total linoleic acid in neutral fat increased more than the neutral fat. This was associated with a marked increase of linoleic acid in fetal liver triglycerides. The ratio of linoleic acid increase between liver and peripheral tissues was 5:3. After irradiation the concentration of free fatty acids in the fetal plasma doubled, but there was no increase in the linoleic acid fraction. The triglyceride concentrations in the fetal plasma increased by about 100%, which was in close proportion to the triglyceride content observed in the fetal livers. (BBB)

**29805** EXPERIMENTAL CONGENITAL MALFORMATIONS OF THE MOTORSKELETAL SYSTEM. Pappas, Arthur M. (Children's Hospital Medical Center, Boston. Harvard Medical School, Boston). Clin. Orthop. Related Res., 59: 249-76(July-Aug. 1968).

The history of commonly acknowledged causes of experimental skeletal malformations, namely, hormones, drugs and chemicals, dietary factors, radiation, infectious agents and immunologic factors, have been reviewed, and the presumed mechanisms of teratogenesis discussed. The concept that teratogenic insults at graduated critical developmental periods result in a spectrum of skeletal abnormalities is emphasized; and the anatomic expression of the ultimate anomaly is dependent on the dose of the teratogenic agent and the stage of development. The closing section is an attempt to analyze critically the known genetic, intracellular,

intercellular and metabolic mechanisms which result in the abnormalities of skeletal morphogenesis. (auth)

**29806** EFFECTS OF $^{60}$Co IRRADIATION ON THE MENISCEAL TISSUE: AN EXPERIMENTAL STUDY ON DOGS. Rissanen, Pentti; Rokkanen, Pentti; Paatsama, Saki (University Central Hospital, Helsinki. Coll. of Veterinary Medicine, Helsinki). Strahlentherapie, 137: 68-73(Jan. 1969).

The effect of $^{60}$Co irradiation on the menisci of the knee (femorotibial) joint of 12 dogs of various ages was studied histologically, histochemically, by polarised light microscopy and by autoradiography using $^{35}$S. Single doses from 1000 to 4000 rad were used. The changes were analyzed after four days, two weeks, and two months. Increased metachromasia was evident between the bundles of collagen fibres at four days and two weeks after irradiation. Similarly, an increase in radioactive sulfur accumulation was noted. Two months after irradiation, these changes were less obvious or had disappeared completely. Polarization of the bundles was greatly reduced and irradiation with the larger doses had caused fragmentation of the fiber bundles. (auth)

**29807** NEW FINDINGS ON THE ACTIVITY OF THE ADRENAL CORTEX IN WHOLE-BODY-IRRADIATED RATS. Flemming, Kurt (Heiligenberg-Institut, Ger. Univ., Freiburg i. B.). Strahlentherapie, 137: 82-7(Jan. 1969). (In German).

The first and second increase of corticosteroids after whole body irradiation in mice was studied. The first increase reaches its maximum after 5 minutes and can be observed for 150 minutes. It is caused by neural excitation. Its evolution is nonspecific (stress) but the causes are specific. The second increase occurs between the second and fourth day. Its intensity and duration are dose dependent. Its maximum always occurs at the 3rd day and is not dose dependent. After 500 and 1000 R the increase is reversible, but not after 1200 R. This is caused by intestinal lesion. The toxic substances as bacterial endotoxin are probably the cause of this second elevation. (auth)

**29808** CITRATE SYNTHASE, ACETYL-COENZYME A AND CITRATE IN THE MOUSE LIVER FOLLOWING WHOLE-BODY IRRADIATION. Berndt, Juergen; Gaumert, Renate (Univ., Freiburg i. B.). Strahlentherapie, 137: 88-91(Jan. 1969). (In German).

After whole-body x irradiation the activity of citrate synthase was measured in the liver of fed mice, whereas the contents of acetyl-CoA and citrate were measured in the liver of 24 hr starved mice. The citrate synthase activity and the content of acetyl-CoA are changed only slightly during a period of 16 days after irradiation while the content of citrate is increased by about 25% at the late days after irradiation. These findings lead to the assumption that acetyl-CoA is introduced by the condensing enzyme into the Krebs cycle in an almost normal rate even after a high radiation dose. Further consequences for the acetyl-CoA metabolism after x irradiation are discussed. (auth)

**29809** INFLUENCE OF WHOLE-BODY X IRRADIATION ON $^{14}CO_2$ EXHALATION BY GUINEA PIGS AFTER ADMINISTRATION OF $^{14}$C-GLUCOSE AND $^{14}$C-SUCROSE. Meissner, Johannes; Thumser, Elke; Hansen, Hans-Georg (Forschungsinstitut Borstel, Luebeck. Medizinische Akademie, Luebeck). Strahlentherapie, 137: 110-18(Jan. 1969). (In German).

After oral administration of $^{14}$C-glucose and $^{14}$C-saccharose to guinea pigs non-irradiated and fasting, the exhalation of $^{14}CO_2$ is about equal. Non fasting animals received 5 g of glucose 1 hour prior to the $^{14}$C-compounds resulting in a delay of the oxidation. After intracardiac injection of $^{14}$C-glucose the exhalation is initiated faster than after oral administration. $^{14}$C-saccharose injected intercardially results in only a trace $^{14}CO_2$ expiration. Irradiated animals were examined over a period of one to ten days. After oral application of $^{14}$C-glucose fasting animals show an accelerated oxidation and increased rates of $^{14}$C-exhalation only just before exitus thus revealing a more pronounced intestinal permeability. When administering $^{14}$C-saccharose the $^{14}$C-exhalation curve indicates a delay of oxidation during the first days. This difference to $^{14}$C-glucose utilization seems to be caused by a partial and temporary inhibition of the disaccharide crack. Shortly prior to exitus the $^{14}CO_2$-exhalation increases for $^{14}$C-saccharose as well as for $^{14}$C-glucose. Non-fasting irradiated animals receiving additional glucose before $^{14}$C-saccharose tests show an increase of $^{14}CO_2$-exhalation which however varies considerably in its extent. (auth)

**29810** ON THE NATURE OF THE RESISTANCE EFFECT APPEARING AFTER RADIATION. PART IV. CHARACTERISTICS OF THE TWO COMPONENTS. Waldschmidt-Leitz, Ernst; Keller, Lorenz (Heiligenberg Instituts, Ger.). Strahlentherapie, 137: 78-81(Jan. 1969). (In German).

After irradiation of goats, two substances appear, related to radioresistance, one in the plasma, the other in the blood corpulses. It is shown that both substances are of macromolecular and protein nature. (auth)

**29811** LIFE-SHORTENING OF MICE AFTER LONG TERM IRRADIATION WITH X-RAYS. Heuss, K. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Biophysik, 5: 261-75 (1969). (In German).

Results of long-term irradiations of mice with x rays (dose rates 0.8 to 750 R/day) were reported. Life shortening in these experiments may be calculated from results of age dependency of life shortening after single short irradiations with low doses. In long-term irradiations life shortening is caused mainly by the dose received during the juvenile period. A model is proposed, which relates life shortening in long term irradiations with dose rate. Irradiation of the upper or the lower part of the body of a mouse with 2 × 300 R results in the same life shortening. (auth)

**29812** SOME CHANGES IN WHITE BLOOD CELLS IN FASTING RATS AFTER TOTAL-BODY IRRADIATION. Samanek, Mojmir; Hampl, Vladislav; Tusl, Miloslav. Sb. Ved. Pr. Lek. Fak. Karlovy Univ. Hradci Kralove, 10: 581-9(1967). (In Czech).

In the course of radiation sickness the metabolism of the irradiated organism is markedly disturbed. The effect of an additional metabolic load, ten days' fasting with a 30% weight decrease, on the level of eosinophil granulocytes in the peripheral blood and on the tinction of nuclear blood elements with acridine orange was studied. Ninety white female rats 6 to 7 months old received 600 R of total-body x-radiation. Immediately after irradiation the animals were divided into 2 groups, one kept without food supply and receiving water ad libitum for 10 days, the other fed on Larsen's diet. The same 2 groups were formed from 90 additional nonirradiated animals. The rats were examined at 0, 1, 3, 6, and 10 days after irradiation. A sharp decrease in the number of eosinophil granulocytes with the lowest values (2 to 3% of original level) at 6 days was found in both irradiated groups. The share of fasting on this decrease was statistically significantly higher ($p = 0.05$) in irradiated animals at 1, 3, and 6 days, while at 10 days the differences between the irradiated and nonirradiated animals were almost balanced. In the tinction of nuclear blood cells with acridine orange the changes in fasting irradiated animals were insignificantly smaller than in the fed ones. This fact could suggest a positive effect of fasting, however a longer and more detailed proof would be needed. (auth)

## Man

*Refer also to abstracts 29321, 29354, 29355, 29357, 29375, 29406, 29493, 29498, 29541, 29542, 29555, 29556, 29559, 29578, 29580, 29590, 29593–29598, 29651, 29661, 29662, 29664, 29668, 29675, 29677, 29680, 29681, 29684, 29700, 29702, 29709, 29710, and 29711.*

**29813** (A-AC-82/G/L-1255) SOME CHANGES IN THE MOTOR REACTIONS OF PERSONS WORKING IN CONDITIONS OF CONTINUOUS RADIATION EXPOSURE. Barabanova, A. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1968. 18p. (In Russian). Dep.

Persons who were chronically exposed to radiation during work, such as reactor and accelerator personnel, medical radiologists, persons working with phosphors and with industrial flaw detectors, and scientists and technicians working with unsealed sources, were examined to determine the radiation-induced changes in their motor reactions. Electromyographic and stabilographic methods were used; the electromyograms were recorded by a 15-channel electroencephalograph. The data represented an expansion of the standard values; they were very unstable. The motor reactions followed the general worsening tendency of the nervous system and of the organism as a whole. Persons exposed to 50 to 70 rad seemed to increase their bioelectric activity; this tendency was more marked in persons suffering from chronic radiation sickness who also exhibited considerable regulatory instability in their vascular and motor reactions. In persons with the asthenic syndrome, the bioelectric activity was greatly reduced; this followed the pattern of biochemical injury of the metabolism of the muscles; however, all these changes were unstable and often reversible. (TTT)

**29814** (A-AC-82/G/L-1264(Add.1)) EFFECTS OF IONIZING RADIATION ON THE NERVOUS SYSTEM. PART II. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1968. 78p. (In Russian). Dep.

Abstracts were prepared for each of the four papers presented and are included in NSA. (C.O.)

*For abstracts of individual papers see: 29815–29818.*

**29815** (A-AC,82/G/L-1264(Add,1), pp 3-14) SYSTEMATIC TECHNIQUES OF THE OBJECTIVIZATION OF THE ASTHENITIC SYNDROME, DUE TO THE ACTION OF IONIZING RADIATIONS. Ginzburg, D. A.; Losev, A. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). (In Russian).

Several methods were used to evaluate the changes of the functional state of the central nervous system resulting from the action of low radiation doses which cause the asthenic syndrome. This evaluation is best carried out by analyzing the neuro-physiological shifts due to an exciting agent, such as the radiation. Persons exposed to radiation were examined, determining the fatigue and functional mobility of sight and hearing. The corrective tests needed for understanding, and the electrophysiological recording of electroencepha-biograms, electromyograms and of vegetative indicators, such as electrocardiograms, breathing rate, galvanic reactions of the skin, etc., were also examined during the response to light and sound signals. The results indicated that patients exhibiting the asthenic syndrome made an average of six times more errors than persons in the control group. This methodic approach was also useful to detect defects in the neurodynamic reorganization which results from the altering of control and evaluative processes, as shown by the bioelectric data of the brain, and the breakdown of the vegetative processes and the increase of emotional tension. (TTT)

**29816** (A-AC,82/G/L-1264(Add,1), pp 15-29) CLINICO-BIOCHEMICAL RELATIONS OF SOME INDICATORS OF THE FUNCTIONAL STATE OF THE MUSCLES IN THE CASE OF CHRONIC EXPOSURE TO IONIZING RADIATION. A CLINICO-EXPERIMENTAL STUDY. Sadchikova, E. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). (In Russian).

The functional state of the muscular system of persons exposed to chronic occupational irradiation was studied, trying to determine the most sensitive tests to indicate changes. Clinical-neurological observations and biochemical analyses of the blood serum and urine were used as chief tests, determining the activity of certain enzymes, such as aldolase, asparate aminotransferase, alanine aminotransferase and the creatine and creatinine content. Data collected for 44 healthy persons were used as reference, comparing the values obtained from the study of 89 patients exposed previously to near-permissible doses for extended periods. A definite correlation was found between clinico-physiological disturbances in the motor system, the biochemical findings and the total dose during occupational exposure. The development of the astheno-neurotic syndrome with functional changes in the motonervous system was accompanied by disturbances in the creative metabolism; however, the activity of the enzymes was the same as in the control individuals. It is proposed that biochemical tests may be applied to the study of the reaction of the tissue to low, chronic doses of irradiation. (TTT)

**29817** (A-AC,82/G/L-1264(Add,1), pp 30-43) CLINICO-PHYSIOLOGICAL METHODS FOR THE STUDY OF THE ASTHENIC SYNDROME, ARISING IN PERSONS IN CONTACT WITH IONIZING RADIATION. Glazunov, I. S.; Blagoveshchenskaya, V. V.; Martynova, G. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). (In Russian).

Asthenia caused by occupational exposure to ionizing radiation among radiologists and persons operating $\gamma$-sources for flow detection was studied by clinical observation, in order to establish the conditions leading to chronic radiation sickness. The functions of the central nervous system were determined by examining the threshold values, adaptation, and fatigue of tasting and smelling and touching organs with respect to irritants. Special attention was paid to the study of memory and the effect of radiation on the brain function in general. The results indicated the following variants of changes of the central neurodynamics in patients exhibiting the asthenic syndrome: weak internal control while the exciting process is maintained; weak excitation when the control process is maintained; gradual weakening of the nerve processes. Thus, the clinico-physiological studies led to the conclusion that asthenia leads to reduction of the functional activity of the nervous system, as a result of the exhaustion of the compensative-adoptive reactions. (TTT)

**29818** (A-AC,82/G/L-1264(Add,1), pp 44-78) CLINICO-PHYSIOLOGICAL CHARACTERISTICS OF THE STATE OF THE NERVOUS SYSTEM IN THE ACUTE RADIATION SICKNESS OF MAN. THE ACUTE RADIATION SICKNESS AND ITS CONSEQUENCES. Glazunov, I. S.; Blagoveshchenskaya, V. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). (In Russian).

The affliction of the central nervous system in radiation sickness has not been sufficiently well treated in the literature; this is due in part to the supposed resistance of the nervous system to radiation. The early investigators in the U.S. were not concerned at all with neurological analyses. Review of the clinico-physiological studies indicates that the nature and the level of neurological disturbances depend on the radiation dose and the severity of the sickness. Up to 1000 R, humoral reflex changes take place and disturbances of the nerve tissues are pushed in the background; at more massive doses, a fast-acting form of the sickness appears, causing deep destructive changes in the central nervous system. The cerebral and meningeal phenomena are described and clinical features are analyzed. The clinico-neurological picture, including asthenia, the diencephalic syndrome, the radiation encephalopathy, the asthenodystrophic syndrome, and functional changes of the vegetative nervous system, is the result of complex processes in the nervous system which arise at the start of the sickness and become irreversible. Endocrine and morphological changes of the nerve structure and vascular system also play an important role (Review article, 154 references). (TTT)

**29819** (ACRH-30, pp 69-91) RADIUM-INDUCED MALIGNANT TUMORS IN MAN. Finkel, A. J.; Miller, C. E.; Hasterlik, R. J. (Argonne Cancer Research Hospital, Chicago, Ill.).

The long-term effects of radium deposition in man are reviewed and data are interpreted on the basis of radium-induced malignant tumors. Aspects of the consequences of Ra deposition in skeletal tissue viewed after a considerable lapse of time were not considered. Mathematical power function parameters for retention of radium in the body following ingestion are presented and discussed. From the tabulated data collected on radium dial painters, it was estimated that each subject received a maximum front surface dose of about 0.6 mR/hr, a back surface dose of about 0.3 mR/hr, and a midline dose of about 0.62 mR/hr; in these calculations the $\beta$ radiation was ignored. It was concluded that the external radiation could be safely ignored as an oncogenic agent. The results of other computations are presented in tabular form; the estimated maximum burdens ranged from 6.72 to 66.49 $\mu$Ci for bone sarcoma, 1.23 to 1.63 $\mu$Ci for radium-induced skull carcinoma, and 52.48 to 101.42 $\mu$Ci for leukemias and aplastic anemias. No person that was studied whose maximum Ra burden was estimated to be below 1.2 $\mu$Ci developed a malignant tumor that could be ascribed to radium deposition. (C.O.)

**29820** (ACRH-30, pp 92-6) OPHTHALMOLOGICAL ASPECTS OF CARCINOMA OF THE SPHENOID SINUS INDUCED BY RADIUM POISONING. Hasterlik, R. J.; Lawson, L. J. Jr.; Finkel, A. J. (Argonne Cancer Research Hospital, Chicago, Ill.).

A case study of a woman treated with radium salts and with subsequent carcinoma of the sphenoid sinus involving the sixth cranial nerve on the right by extension and secondary to the presence of radium is presented. The purpose of the report was to acquaint ophthalmologists with the general manifestations of radium poisoning and to record a specific illustrative case. (C.O.)

**29821** (BNL-13584) EFFECTS OF FALLOUT RADIATION ON MARSHALLESE CHILDREN. Sutow, Wataru W.; Conard, Robert A. (Brookhaven National Lab., Upton, N. Y.). Apr. 21, 1969. 21p. (CONF-690501-2). Dep. CFSTI.

From 9th Annual Hanford Symposium on Radiation Biology of the Fetal and Juvenile Mammal, Richland, Wash.

On March 1, 1954, native inhabitants of several atolls in the Marshall Islands were exposed accidentally to fallout radiation following the experimental detonation of a large thermonuclear device at Bikini Island. The heaviest fallout occurred on Rongelap Island, downwind and about 100 miles east of Bikini. Since that time the exposed people have undergone regular and intensive medical examinations, the results of which have been documented in a number of publications. The findings on the exposed Rongelap people who were children at the time of exposure are summarized. In particular, these findings are compared to those noted in the exposed adult population. (auth)

**29822** (CISE-117) PROBLEM OF HEALTH PROTECTION FROM LASER RADIATION. Bazzano, E.; Ghislandi, E. (Centro Informazioni Studi Esperienze, Milan (Italy)). May 1968. 40p. (In Italian). (CONF-680535-1). Dep.

From 14th National Conference of the Italian Association for Health Physics and Protection from Radiation, Formia, Italy.

The physical characteristics of laser light and its various types of emission are briefly summarized. The action of laser light on biological systems and its pathological effects are described with emphasis on the lesions of the eye and of the skin. Because of the increasing use of lasers in many diverse fields, the risks of a professional nature for personnel connected with the operation of lasers are illustrated. The importance of preventive and periodic medical controls as well as prophylactic measures are discussed. (tr-auth)

**29823** (JPRS-46947) BIBLIOGRAPHY ON AEROSPACE MEDICINE AND BIOASTRONAUTICS FOR 1967. Boreva, L. I.; Panova, E. M. (comps.). Translated from the Russian. 56p. CFSTI.

References are presented on 451 Soviet publications during 1967 on space medicine and related biological and dosimetry studies. (C.H.)

**29824** (SC-T-69-1021) INFLUENCE OF WEAK ELECTROMAGNETIC FIELDS ON THE CIRCADIAN CYCLE OF HUMANS. Wever, Ruetger. Translated by Marcel I. Weinreich (Sandia Labs., Albuquerque, N. Mex.), from Naturwissenschaften, 55: 29-32(1968). 11p. Dep. CFSTI.

Based on the shielding studies, the results mean that the natural electromagnetic fields exert the same effect upon the circadian cycle of man as an artificial electrical 10-Hz field: Both fields act as an accelerator upon the periodicity. As the various scatterings of the periods measured around the respective mean values have demonstrated, this accelerating effect increases with a prolongation of the period when the field is absent. Both fields inhibit (prevent) the internal de-synchronization that can be observed only in the absence of both natural and artificial fields. It is still impossible to decide the extent to which the natural fields through their diurnal course of intensity, as well as the artificial fields, can serve as time indicators during periodic off-and-on switchings, since research regarding the influence of intensity is still lacking. And so it can be said that the natural electromagnetic fields of terrestrial origin can be replaced by artificial electrical 10-Hz fields, as regards their effect upon periodicity. This may be significant under conditions where the natural fields are absent (e.g., investigations in steel chambers or in outer cosmic space). This mutual interchangeability does not mean, however, that the 10-Hz radiation is the only component of the natural fields that acts upon man; yet, it is a strong indication that the 10-Hz radiation is an essential component of those fields, at least as regards the effect on the circadian periodicity (cycles). The experiments show, on the one hand, that the circadian periodicity can also be affected by imperceptible physical factors, and, on the other hand, that previously disregarded factors of our natural environment are perfectly able to exert a measurable influence upon man. (auth)

**29825** (UCRL-18347, pp 1-9) LEUKEMIA IN POLYCYTHEMIA VERA: RELATION SHIP TO SPLENIC MYELOID METAPLASIA AND THERAPEUTIC RADIATION DOSE. Lawrence John H.; Winchell, H. Saul; Donald, William G. Jr. (California Univ., Berkeley).

Since the initial use of $^{32}PO_4$ in our clinic for the treatment of polycythemia vera (PV) in 1936 we have followed to termination 181 cases of PV treated with $^{32}P$ or with $^{32}P$ and x ray. Of these, 45/181 (25%) developed significant splenic myeloid metaplasia and 26/181 (14%) developed an acute myelogenous leukemia-like state. Sixteen cases had both acute leukemia (AL) and significant splenic myelopoiesis or myeloid metaplasia (MM) (i.e., 16/45 or 36% of all cases with MM developed AL), and 10 cases had only acute leukemia but no significant splenic myeloid metaplasia (i.e., 10/136 or 7% of all cases without MM developed AL). Patients who failed to develop MM or AL or both were older at the time of onset and diagnosis and failed to survive as long as those who did develop MM or AL or both. The survival of patients who developed acute leukemia (AL) was not significantly different from that of patients who died with significant myeloid metaplasia (MM) alone. The largest values of overall radiation exposure (both $^{32}P$ and x ray) times at risk were received by patients dying with splenic MM alone. The overall incidence of AL in this series of patients with polycythemia vera was 20 to 40 times that expected for a population of normal human subjects exposed to similar radiation doses and times at risk. These data are consistent with the hypotheses: that development of significant splenic myeloid metaplasia (MM) and acute leukemia-like states (AL) are part of the evolutionary history of PV; that MM usually precedes the appearance of AL; that the incidence of AL in patients treated with $^{32}P$ is primarily a result of prolonged survival rather than of radiation dose. (auth)

**29826** (UCRL-50387(Add.)) AN ANALYSIS OF THE CARCINOGENIC RISK FROM AN INSOLUBLE ALPHA-EMITTING AEROSOL DEPOSITED IN DEEP RESPIRATORY TISSUE: ADDENDUM. Geesaman, Donald P. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 9, 1968. 11p. Dep. CFSTI.

Several experiments are reviewed involving skin and lung carcinogenesis in mammals after intense localized doses of ionizing radiation. A high incidence of cancer occurs for the exposures described. The observations suggest that the carcinogenesis is primarily mediated by injury or disruption of local tissue. It is concluded that there is a substantial possibility of enhanced cancer risk associated with the deposition of intense $\alpha$-emitting particulates in deep respiratory tissue. Within this description lung cancer risks as high as $10^{-3}$ to $10^{-4}$ per disruptive source particle are indicated. The possibility of this enhanced risk places the present standards for maximum permissible lung burdens in serious question when applied to particulates such as $^{238}PuO_2$ and $^{239}PuO_2$. It is suggested that in the absence of a detailed knowledge of pulmonary carcinogenesis, the best course of action is an experimental determination of the risk per disruptive particle for particle burdens $\ll 10^8$ particles. (auth)

**29827** THE SIGNIFICANCE OF LIGHT TRAUMA FOR THE INDUCTION, LOCALIZATION, AND FREQUENCY OF SKIN CANCERS. Jakac, D. (Dermatological Clinic, Rijecka, Yugoslavia). Hautarzt, 19: 157-8(Apr. 1968). (In German).

Characteristics of skin tumors in the Rijecka coastal areas of Yugoslavia are reviewed and described. Skin tumor incidence is about 94% on unprotected portions of the face. Long, intermittent exposure to uv irradiation combined with other climatic factors, such as high or low temperatures, dry or moist air, wind, fog, cloudiness, and rain predispose persons to definite pathological skin changes. Solar irradiation and absorption of uv radiation induces photochemical reactions and qualitative changes that are characterized by degenerative processes of collagen, reticulum, and elastic fibers. Keratoses are formed from which tumors may develop. Other factors, such as genetic characteristics, color of eyes, hair, or skin, pigmentation, petroleum derivatives, and chronic trauma, are frequently cofactors with uv irradiation that produce skin tumors. (BBB)

**29828** EPIDEMIOLOGY OF PRECANCEROUS AND MALIGNANT TUMORS OF THE SKIN. II. CARCINOMA OF THE SKIN. Jung, H.-D.; Koelzsch, J. (Hautabteilung des Kreiskrankenhauses, Paseweld/Ruhleben, Ger.). Hautarzt, 19: 151-7(Apr. 1968). (In German).

The epidemiology of skin cancers in the Neubrandenburg area of East Germany is presented and summarized. Those who are predisposed to skin carcinoma by exposure to uv irradiation include the aged and people engaged in seafaring or agricultural vocations, or persons with xeroderma pigmentosum. In persons with xeroderma pigmentosum, it is not known whether the increased penetrability of the skin to uv irradiation is alone responsible for the disposition to tumor, or whether other, endogenous factors, such as disturbance of Cu metabolism, decreased glutathione level, or increased melanogenesis may act in combination with exposure to uv irradiation to produce skin tumors. Long-term treatment with vitamins A and E suppresses the hyperpigmentation produced by uv irradiation, and lowers the serum Cu and glutathione levels, which decreases skin tumor incidence. The incidence of skin tumors in the facial area of 58 to 96% indicates the injurious effects of uv irradiation. (BBB)

**29829** IRRADIATION INJURIES OF THE INTESTINES. Schmitz, Robert L. (Stritch School of Medicine, Chicago). J. Okla. State Med. Ass., 61: 450-4(Sept. 1968).

The occurrence, prevention, and treatment of intestinal injury as a result of radiotherapy are considered, with reference to 10 cases. If the exposure is in large doses at short intervals in a total amount exceeding 4500 R, the effects on intestine may be pronounced. The bowel wall may become edematous, ulcerations of the mucosa will be deep and may bleed significantly, peristalsis will be more active, and bloody diarrhea, nausea, and vomitting may be so severe as to require parenteral fluids and blood replacement. When the dosage is heavy enough in a localized area, necrosis of the bowel may occur with sloughing or perforation. If the symptoms continue, a diversionary colostomy should be done to allow healing. In six to eight months it can be closed. Principles of surgical treatment are described. Corrective surgical procedures may be diversionary, resective, or plastic, in nature. Diversity operations include ileocolostomy and colostomy. Ileocolostomy is used to bypass injuries in the terminal ileum. Occasionally, it is the initial operation in a two-stage resection of an ileovaginal fistula. Colostomy is used as a temporary bypass for irradiation proctitis of the distal colon and/or rectum. Colostomy is used as a permanent bypass for rectovaginal fistulas when no tumor remains. Resective operations range from simple excision with end-to-end anastomosis to total pelvic exenteration. When excision of small or large bowel lesions is done, the surgeon must move proximally and distally far enough to secure normal bowel for anastamosis. Plastic operations have little place in the treatment of these injuries. Dissection through irradiated tissues leads to sloughing and breakdown. Therefore, plastic operations are rarely satisfactory and this is essentially true in the treatment of rectovaginal or vesicovaginal fistulas following irradiation. (BBB)

**29830** TREATMENT OF HYPERTHYROIDISM. Engbring, Norman H. (Marquette School of Medicine, Milwaukee). Wis. Med. J., 67: 265-7(May 1968).

Indications for and risks attending $^{131}I$ treatment of hyperthyroidism are reviewed. The major disadvantage to radioiodine therapy is the relatively high incidence of subsequent hypothyroidism that may be expected in 20 to 50% of patients within 20 yr after therapy. This incidence undoubtedly will increase as treated groups are observed for longer periods. Other disadvantages are largely theoretical and include the possibility of carcinogenesis that applies particularly to young patients, and genetic defects that may become apparent in future generations. The consistent demonstration of chromosomal abnormalities in white cells of radioiodine-treated patients warrants continued concern over these theoretical disadvantages. When hyperthyroidism occurs after the childbearing age, radioiodine is the best treatment. This will include most patients. Relatively small (3 to 10 mCi) doses are required for the diffuse toxic goiter of Graves' disease, and in these patients the incidence of hypothyroidism will be greater. Considerably larger doses (up to 30 mCi) may be required for patients with toxic multinodular goiter (Plummer's disease), but the incidence of hypothyroidism in these cases is relatively low. Exacerbation of the hyperthyroidism may rarely occur after radioiodine therapy in the very toxic patient. Radioiodine therapy is also preferred for recurrent or persistent hyperthyroidism after thyroidectomy, and may be the preferred therapy for young patients who cannot be managed with antithyroid agents and who have medical problems that make surgery a considerable risk. (BBB)

**29831** GROSS RADIATION CHANGES OF THE VAGINA. Griffin, Newton B. (Vanderbilt Univ., Nashville). S. Med. J., 61: 1052-6(Oct. 1968).

Complications which may occur in the vagina following radiotherapy of gynecological neoplasms using Ra $\gamma$ implants are discussed, as well as optimal means of supplying irradiation and methods used postoperatively to obviate or lessen vaginal complications. The spectrum of gross radiation changes in the vagina is summarized. (BBB) (TSS)

**29832** IS X IRRADIATION THE CAUSE OR ONLY A FACTOR LEADING TO MANIFESTATION OF AN AUTOIMMUNE-HEMOLYTIC ANEMIA IN CHRONIC LYMPHADENOSIS. Weinreich, J. (Medizinische Akademie, Luebeck). Blut, 16: 81-5(Nov. 1967). (In German).

The development of an autoimmune-hemolytic anemia in a patient with chronic lymphadenosis who was x-irradiated twice within three yr with fractionated doses of 1600 R is described. The anemia appeared soon after the end of the second irradiation series and was successfully treated by transfusions and steroid hormones. After a third irradiation series with a dose of 3000 R and about seven yr after the start of the lymphadenosis, an autoimmune-hemolytic anemia developed that did not respond to treatment. The case is discussed in the light of similar previously reported cases as to whether the irradiations were the direct cause of the anemia, either by activation of an already existent subthreshold process or by eruption of a previous immunotolerance. (BBB)

**29833** SALIVARY GLAND TUMORS OCCURRING AFTER RADIATION OF THE HEAD AND NECK AREA. Ju, David M. C. (Columbia Univ. Coll. of Physicians and Surgeons, New York). Amer. J. Surg., 116: 518-23(Oct. 1968).

Experience of a plastic surgeon demonstrated that irradiation of head and neck areas for a benign condition produced identifiable change of the skin, followed by tumor formation in the salivary glandular tissue. Five cases are reported; each patient had received therapeutic radiation for a benign condition or had occupational exposure. In each patient radiation dermatitis and/or basal cell epithelioma or squamous cell carcinoma of the skin of the head and neck area developed. At a much later date, salivary tumors of the submaxillary or parotid areas developed. There was a definite time lag of about 10 to 20 yr between the date of irradiation and the cutaneous formation of a cancerous lesion, and another lag of about 15 to 25 yr before the development of the salivary tumor. Two additional cases with comparable conditions of radiation-related parotid tumors were also recorded. Most patients were irradiated between the ages of 13 and 16 for excessive facial hair. (BBB)

**29834** THE RADIORENOGRAM IN UTERINE CARCINOMA: EFFECT OF RADIOTHERAPY. Patricio, M. B.; Baptista, A. M. (Instituto Portugues de Oncologia de Francisco Gentil, Lisbon). Arq. Patol. (Lisbon), 39: 139-46(Dec. 1967). (In Portugese).

In 141 patients with cancer of the uterus receiving therapeutic irradiation, 257 renograms were obtained by the use of hippuran labeled with $^{131}I$ showing that this test is effective in demonstrating urinary tract abnormalities. A total of 107 patients had carcinoma of the cervix and 34 had been operated for adenocarcinoma of the corpus. Ninety-three patients (66%) presented abnormal renograms. In 74 patients the renogram was performed before, during, and after $^{60}Co$ irradiation with tumor doses of 4000 to 7000 rad administered over 4 to 8 weeks. When the test was repeated after irradiation in 39.2% of the cases the renogram showed some improvement, in 24% abnormalities remained stationary, in 14.9% deterioration was observed, and in 21.6% of the cases normal renograms were seen. The authors also studied the radiorenographic evolution in relation to the clinical response to radiotherapy. (BBB)

**29835** THE FUNCTIONAL STRUCTURE OF THE LYMPH NODE AS OBSERVED FROM HYPOPLASTIC AND HYPOFUNCTIONAL CONDITIONS OF LYMPHATIC TISSUE. Iijima, Soichi (Hiroshima Univ. School of Medicine). Acta Pathol. Jap., 17: 287-305(Aug. 1967).

A hypoplastic human lymph node showing alymphocytosis and the hypofunctional lymph nodes of experimental animals after irradiation, steroid treatment, neonatal thymectomy, and germfree rearing were studied. The DNA labeling in the lymph node was suppressed most effectively by irradiation. After irradiation of the whole-body with 500 R of x rays the labeling of the cells of the lymph node cortex was temporarily stopped completely. About 24 hr after irradiation the labeling began to recover and this recovery could be detected by the incorporation of $^{3}H$-thymidine in sparsely labeled cells in the first few days. A few highly labeled cells could be found in the cortex four to five days after the irradiation, but thereafter this type of labeling was lacking. The reason why the suppression of the labeling of the latter type persists so long is not clear, but the direct effect of the irradiation is an improbable cause. One factor, considered in this connection is the suppression of lymphopoiesis through lymphopenia. After partial irradiation (60,000 R of x ray) of the tail of the mouse, that caused a marked lymphopenia in the peripheral blood, the labeling of the cells in lymph node protected from irradiation of the same animal was reduced significantly. The decrease of sparsely labeled cells was most striking about four days after partial irradiation and then a long-term suppression of the highly labeled cells followed. Effects of thymectomy and steroid treatment on DNA synthesis were also described. The data indicated the recirculation of small lymphocytes from circulating blood to the lymphatic tissue. (BBB)

**29836** LASER TREATMENT OF TATTOOS: A PRELIMINARY SURVEY OF THREE YEAR'S CLINICAL EXPERIENCE. Goldman, Leon; Rockwell, R. James; Meyer, Robert; Otten, Robert; Wilson, Robert G.; Kitzmiller, K. William (Children's Hospital Research Foundation, Cincinnati). J. Amer. Med. Ass., 201: 841-4(Sept. 4, 1967).

Effects of laser radiation on tattoo pigment in skin were studied. The initial reaction was that of a charring and crusting in the area of the target (1.5 to 2 $cm^2$) with ruby and neodymium lasers. There was also spotted, superficial crusting with the argon laser. Oozing may occur for several weeks after treatment until dry adherent crusts form. After these crusts peel off, a flat reddened area is left. After 3 or 4 weeks, the redness begins to fade. No differences were observed between the pigment masses found in the treated areas and the untreated controls. No marked inflammatory reaction was observed about these pigment masses remaining in the treated areas or adjacent to the target area of the laser beam after healing. After laser impacts, no tattoo particles were detected in normal skin about the tattoo. Side-reactions included secondary infection and hypertrophic scarring. The mechanism that causes the tattoo removal involves a localized vaporization of the dye particles that in a gaseous form, are then expelled from the tissues as part of the laser reaction plume. Tissue damage, as seen in the biopsies, was generally confined to the areas wherein sufficient laser energy was absorbed by the dye particles. (BBB)

**29837** EPIDERMAL CHANGES IN ERYTHROPOIETIC PROTOPORPHYRIA AFTER IRRADIATION WITH GLASS-FILTERED MERCURY LIGHT. Baart de La Faille-Kuyper, E. H.; Rottier, P. B.; Baart de la Faille, H. (Univ. Hospital, Utrecht). Brit. J. Dermatol., 80: 747-8(Nov. 1968).

The effects of uv radiation and visible light (glass-filtered illumination from a Hg vapor lamp) were compared in the skin of patients suffering from photosensitive protoporphyria, which swells with the sensation of burning when exposed to sunlight. Histochemical studies of three patients revealed the presence of lipid droplets in and around small subepidermal blood vessels, and also in the epidermis. This phenomenon was encountered in skin biopsies taken at the sites of a swelling (back, extensor surface of forearm, and back of hand) provoked by glass-filtered Hg light. The dose of light varied from 360 to 720 Wsec/$cm^2$, delivered in 40 to 60 min with an intensity of 0.15 to 0.20 W/$cm^2$ on the skin. The dose necessary to provoke the swelling was two to 40 times the minimum erythema dose (MED). It sometimes

caused a burning sensation like that felt in direct sunlight, never experienced by normal subjects receiving the same dose. When the skin of these patients was repeatedly irradiated on several consecutive days with uv (direct mercury) light (Kromayer lamp) to a total of up to 20 to 40 times the MED, a strong sunburn reaction was seen, but histologically the irradiated skin showed no change in the lipids in and around the small vessels nor in the epidermis. Protoporphyrin absorbs visible radiation much more strongly than short wave uv. The occurrence of lipid droplets in the epidermis only after irradiation with visible light points therefore to the presence of protoporphyrin in the epidermis. (BBB)

**29838** DATA RELATIVE TO THE PROBLEM OF THE POSSIBILITY OF METASTASES FOLLOWING X IRRADIATION OF MALIGNANT MELANOMA. Venkei, T.; Bihari, Oe. (Institut Oncologique National, Budapest). pp 975-6 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In French).

See CONF-670719–(Vol.2).

In order to determine if x irradiation of malignant melanomas favors the metastasis of the tumors, two groups of patients were followed. In the first group the patients received x ray, surgical, and combined treatment. Metastasis occurred within 1 to 6 months in 12.5% of the patients with radiotherapy, 10.0% after surgery, and 6.7% after combined treatment. In the other group the patients received insufficient x ray therapy because surgical intervention caused hemorrhage. In these patients metastases were present in 50.0 to 57.1% of the cases. On the basis of these data, it appears that x radiation does not promote metastasis. (J.S.R.)

**29839** ULTRAVIOLET LIGHT AS A STIMULUS FOR KININ FORMATION IN HUMAN SKIN. Winkelmann, R. K.; Epstein, J.; Wolff, K. (Mayo Clinic, Rochester, Minn. Univ. of California, San Francisco. Univ., Vienna). pp 1045-7 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In German).

See CONF-670719–(Vol.2).

Studies on the detection of histamine and kinin in human skin during the uv latency period by use of the cutaneous perfusion method were reported. The studies were made on healthy males who were exposed to the uv radiation from carbon arc lights and spot quartz lights. The results produced with the two uv sources vary greatly from each other. Under carbon arc uv erythema occurs between 29 and 76 min after the end of the exposure and increases in intensity in the next 24 hrs. Histamine can not be detected in any of the study series. Kinin production begins, however, within 5 to 20 min after the end of the irradiation and is deposited in the latency period. After irradiation with the spot quartz source, uv erythema occurs after 60 to 120 min, but in no case was kinin detectable. The significance of these results is discussed. (J.S.R.)

**29840** ON THE BIPHASIC VASCULAR RESPONSE TO ERYTHEMA INDUCED BY ULTRAVIOLET RADIATION. IS THERE A MORE ELEMENTARY RESPONSE THAN ERYTHEMA? Zina, G.; Benedetto, A. (Univ., Turin). pp 1047-8 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In French).

See CONF-670719–(Vol.2).

The site of the ultraviolet-induced first and second degree erythema was determined and the existence of variations caused in the cutaneous zones by suberythemic doses of ultraviolet radiation was studied. The $^{32}P$ clearance at the site of the erythema was used as the standard of response. The studies showed that at the stimulation site the clearance underwent a slowing down in the latency phase. As first degree erythema was approached, the clearance approached the base values, but did not exceed the first degree values. There was a very rapid acceleration of the clearance when the second degree activity was reached. At the site of the suberythemic stimulation the slowing down phase of the clearance was prolonged and reached much lower values than those at the site of the first and second degree erythema. These results indicated that the suberythemic stimulation provoked functional modifications that could be considered a more basic response to injury than erythema. (J.S.R.) (C.O.)

**29841** CUTANEOUS RADIOBIOLOGY. van Caneghem, P. (Univ., Liege). pp 1069-70 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In French).

See CONF-670719–(Vol.2).

A brief review is given of the problems in cutaneous radiobiology which have received the most study of radiation effects at not over 3000 rads. The problems considered are early erythema, hair as a radiobiological reagent, surface irradiation, and radiation protection. The endogenous substances showing a radioprotective effect are listed, and the comparative effects of cysteamine and cystamine are discussed. (J.S.R.)

**29842** RADIATION EFFECTS ON THE SKIN IN RELATION TO THE QUALITY OF RADIATION USED. Wachsmann, F. (Institut fuer Strahlenschutz der Gesellschaft fuer Strahlenforschung, Munich). pp 1074-8 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In German).

See CONF-670719–(Vol.2).

A bibliographic review is presented of the results obtained in the study of the comparative effects of soft and hard irradiation of the skin. X radiation in the region of conventional radiotherapy is independent of the radiation energy. The effect of hard radiations is discussed and the RBE factors of the skin as obtained by various investigators are illustrated. The selective absorption of certain wave lengths by certain microstructures of the skin is discussed. (J.S.R.)

**29843** RADIATIONS AND CUTANEOUS ELASTIC TISSUE. Ledoux-Corbusier, M. (Univ., Brussels). pp 1093-4 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In French).

See CONF-670719–(Vol.2).

A study was made to establish a parallel between chronic radiodermatitis coming from covered regions of the body and senile elastosis, a dermatitis caused by electromagnetic radiations. In chronic radiodermatitis the lesions extend throughout the dermis and affect the profound vessels whereas in senile elastosis the elastotic hypertrophy is confined to the upper dermis. The comparative study of the spontaneous fluorescence and the induced fluorescence showed a remarkable analogy among the normal elastic fibers, the fibers of senile elastosis, and the fibers of chronic radiodermatitis. The origin of the elastic fibers in chronic dermatitis and senile elastosis appears to be neoformation of the tissues. (J.S.R.)

**29844** PROBLEMS WITH THE USE OF GRENZ RAYS FOR NEGROES AND MULATTOES. Contreras, M. A. (Univ. Nacional Pedro Henriquez Urena, Santo Domingo. Clinica de la Piel Dr. M. Contreras, Santo Domingo). pp 1094-5 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In Spanish).

See CONF-670719–(Vol.2).

The application of grenz rays to individuals of hyperpigmented skin, especially Negroes and mulattoes, produces residual hyperchromias, which have a disagreeable cosmetic effect and take many weeks or months to disappear. Even minimum doses of 200 R will produce these hyperchromias. (J.S.R.)

**29845** LIGHT IS AN AETIOLOGICAL FACTOR FOR CERTAIN DERMATOSES IN U.A.R. El Zawahry, M. (Cairo Univ.). pp 1107-10 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.

See CONF-670719–(Vol.2).

The dermatoses most frequently observed in man living in the United Arab Republic are described and illustrated. Exposure to sun and light was considered to be an aetiological factor in all cases. The diseases were lichen planus tropicus, psoriasis, vitiligo, pellegra, and ulcerated lupus erythematosus. (C.O.)

**29846** THE ABSORPTION SPECTRUM OF THE STRATUM CORNEUM AS THE NATURAL SUNSCREEN OF HUMAN SKIN. Verhagen, A. R. H. B. (Dutch Medical Research Centre, Nairobi, Kenya). pp 1118-22 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 2. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.

See CONF-670719–(Vol.2).

The effect of photochemical decomposition of uv-absorbing substances or any other biochemical alteration as a result of any pathological process on the absorption spectrum of the stratum corneum and consequent transmission through this layer was investigated. Methodology used is described in detail. The changes in normal subjects after irradiation seemed to have little practical importance for protection against sunlight as the area of decreased absorption extended only slightly into the spectrum of natural terrestrial sunlight; the higher absorption around 320 nm may represent a protective action in this spectral area. It was hypothesized that once exposed skin has become eczematized, the diminished absorption of shortwave uv in the dysiunct part might start a

vicious circle: the light protective function of the corneum must be further impaired in the pathologically altered skin. (C.O.)

**29847** SOLAR ULTRAVIOLET RADIATION AND SKIN CANCER. Urbach, F.; Davies, R. E. (Temple Univ. Health Sciences Center, Philadelphia). pp 24-9 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 1. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968.

See CONF-670719-(Vol.1).

Data are presented in support of the following observations: squamous cell carcinoma occurs primarily on skin sites most exposed to uv in sunlight; about one third of basal cell carcinomas normally appear on protected areas—this phenomenon seems to vary with racial origin, being greatest in Celts, where the cancer appears about 10 years earlier, and lowest in darkly pigmented races. Tables are presented giving incidence of cancer by location on the body, by occupation, by exposure, by ethnic origin. (C.O.)

**29848** INFLUENCE OF ARTIFICIAL RADIATION ON MUCOUS MEMBRANE OF THE LIP FROM STEEL HARDENERS. Nicolau, R.; Iacob, P.; Bichis, M. (Union des Societes des Sciences Medicales, Bucharest). pp 87-9 of XIII International Congress of Dermatology, Munich, July 31–August 5, 1967. Volume 1. Jadassohn, W.; Schirren, C. G. (eds.). New York, Springer-Verlag, 1968. (In French).

See CONF-670719-(Vol.1).

Of 70 steel picklers examined, 58 were afflicted with cheilitis. Among the factors contributing to this ailment were thermal and ultraviolet radiation received during the pickling. Prophylactic precautions to prevent or to reduce the number of cheilitis cases are presented. (J.S.R.)

**29849** POLYCYTHEMIA VERA AND MYELOSCLEROSIS: A BONE MARROW STUDY. Roberts, B. E.; Miles, D. W.; Woods, C. G. (General Infirmary, Leeds, Eng.). Brit. J. Haematol., 16: 75-85(Jan.-Feb. 1969).

The effect of $^{32}P$ on bone marrow was examined in the course of a study of bone biopsies performed in 38 patients suffering from polycythemia vera and other myeloproliferative disorders. Fifteen of the patients had received doses of $^{32}P$ ranging from 3 to 42 mCi. Bone marrow was assessed histologically with particular reference to cellularity and reticulin. Marrow cellularity was raised in polycythemia vera and sometimes became normal following radiophosphorus therapy. Marrow cellularity was proportional to spleen size and a linear relation between marrow cellularity and packed cell volume was demonstrated. Studies of the reticulin fibers in bone marrow showed that they increase in density with an increase in marrow cellularity, and that an increase is neither characteristic of any specific myeloproliferative disorder nor is it related to radiophosphorus therapy. It was concluded that the histological diagnosis of myelosclerosis should be confined to bone marrow showing evidence of fibroblastic proliferation and disruption of marrow architecture by a process of fibrosis, and should not be made on the basis of reticulin density. (BBB)

**29850** PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON LEUKEMIA–LYMPHOMA HELD AT ANN ARBOR, MICHIGAN, OCTOBER 9–13, 1967. Zarafonetis, Chris J. D. (ed.). Philadelphia, Lea and Febiger, 1968. 529p. $15.00. (CONF-671073).

Eleven papers were prepared for inclusion in NSA. Forty-four other papers deal with aspects of the conference topic outside the scope of NSA. (C.O.)

*For abstracts of individual papers see: 29299, 29406, 29591, 29665–29671, and 29769.*

**29851** DANGERS FROM IONISING RADIATIONS ASSOCIATED WITH SPACE FLIGHTS CARRIED OUT WITH HUMAN CREWS. NOTE II. PRELIMINARY OBSERVATIONS CONCERNING BIOLOGICAL DAMAGE ATTRIBUTABLE TO RADIATIONS ENCOUNTERED IN SPACE. Agati, G.; Judica-Cordiglia, A. (Univ., Turin). Minerva Radiol., 13: 335-46(June 1968). (In Italian).

The dangers derived from ionizing radiation during space flight are discussed. Data from biological research carried out in extra-atmospheric space during the period 1951 to 1967 are reviewed. Reference is made to modern views concerning the mechanism of action of cosmic radiation and particular attention is paid to heavy nuclei and protons. Lastly, consideration is given to problems associated with protection against radiation in space and these are dealt with on the basis of the experience gained in the first flights carried out in space with human crews. (auth)

**29852** EFFECT OF SUPERVOLTAGE THERAPY FOR CARCINOMA OF THE BLADDER ON THE OUTFLOW FROM UPPER URINARY TRACT TO BLADDER. Edsmyr, F.; Giertz, G.; Nilsson, A.-E. (Karolinska Sjukhuset, Stockholm). Scand. J. Urol. Nephrol., 1: 247-52(1967).

Follow-up studies were made in 111 patients on the effect of radiation therapy on normal ureteric orifices and on orifices constricted by bladder tumors of infiltrative growth. Supervoltage therapy by an external $^{60}Co$ apparatus had been given to all the patients for average tumor doses of 5500 to 7000 rad given over a period of 5 to 7 weeks. Both ureteric orifices received the same radiation dose in every instance. Of the 81 patients examined before and after radiation therapy, 32 showed signs of ureteric obstruction prior to treatment. In all but one case in which a partial obstruction to flow was found before radiotherapy, there was normalization after treatment. Regression occurred in the remaining cases. Three kidneys, which before irradiation had been nonfunctional, started to function again after irradiation. The outflow was fully normalized in 2 of these cases. Attempts were made to discover whether the outflow of healthy ureteric orifices was affected by the radiation reaction, both shortly after treatment and later. In no case was an obstruction to outflow demonstrable as a sequel to the treatment. Impaired outflow after radiation therapy was, as a rule, a sign of tumor progression. (BBB)

**29853** CHANGES IN THE WHITE BLOOD PICTURE FOLLOWING THERAPY OF PATIENTS WITH TUMORS WITH TELECOBALT THERAPY AND INHIBITING BETATRON IRRADIATION. Chvojka, Zdenek. Sb. Ved. Pr. Lek. Fak. Karlovy Univ. Hradci Kralove, 10: Suppl., 469-74(1967). (In Czech).

The only substantial change in the blood picture of man after treatment with a cobalt unit or betatron x rays is a decrease in leukocytes to leukopenia. The differences in these changes in both kinds of treatment are discussed. (auth)

**29854** NORMAL RANGE. Brit. Med. J., 1: 268-9(Feb. 1, 1969).

A report of normal hematologic parameters in radiation-exposed workers is briefly reviewed. The report from the health physics and medical division of the U. K. Atomic Energy Research Establishment draws attention to the range of normal values for the total and differential white cell count. The report analyzes the results of blood counts which were carried out on employees in 1962 and new entrants in 1965-1966 at the Atomic Energy Research Establishment (A.E.R.E.), Harwell. The counts were made on capillary blood from the forefinger and accepted methods were used. A total of 4195 males and 756 females was examined. Analysis of the data suggested a need for slight extension to the currently accepted normal ranges for the total and differential leukocyte counts to cover 95% of their observed values. The present ranges of normal values in use at the A.E.R.E. are in reasonable agreement with those generally accepted, but the adoption of the revised ranges might reduce needless repetition of blood counts in cases at present considered borderline. It is pointed out that experience showed that the ordinary blood count is not a sufficiently delicate indicator for the detection of minor damage to individuals exposed to low-dose irradiation. The report showed that there was very little difference in the mean values for total leukocytes, lymphocytes, and monocytes in the radiation-exposed and nonexposed groups of workers. The mean neutrophil count was a little lower and the mean eosinophil count rate higher in the group exposed to radiation, but this may not reflect actual exposure to radiation. (BBB)

**29855** THOROTRASTOSIS OF THE RETICULOENDOTHELIAL SYSTEM, AN IATROGENIC FORM OF THESAURISMOSIS. Verhaak, R. L. O. M. (St. Ignatius Ziekenhuis, Breda, Netherlands). Ned. Tijdschr. Geneesk., 112: 789-97(Apr. 27, 1968). (In Dutch).

A review is presented of the properties of Thorotrast, a colloidal contrast agent containing 25 vol % (19–20 wt %) $ThO_2$, the extent of its diagnostic use in the Netherlands, and sequelae of its deposition in the tissues. The Th, with a half-life of $1.39 \times 10^{10}$ yr, is taken up up mainly by the reticuloendothelial system (RES). A description is given of thorotrastosis of the RES, an iatrogenic form of thesaurismosis. Data are presented concerning the long-term sequelae of injection of Thorotrast into or near the blood vessels, which sequelae have been encountered with increasing frequency, especially in recent years. Emphasis is laid on the need of tracing and follow-up of certain groups of patients who received Thorotrast. Nephrectomy may be advised, for example, in patients who have extensive $ThO_2$ deposits in the kidney to avoid occurrence of tumors in this organ. (BBB)

**29856** MONOBLASTIC LEUKEMIA IN A PATIENT WITH THOROTRASTOSIS. Porton, W. M.; Revers, F. E. (Diakonessenhuis, Utrecht). Ned. Tijdschr. Geneesk., 112: 797-8(Apr. 27, 1968). (In Dutch).

The case is reported of a woman who, 13 yr after cerebral arteriography presented thorotrastosis associated with monoblastic leukemia. The 74-yr-old patient had developed paretic

symptoms on the left side. The total leukocyte and erythrocyte levels in blood were markedly decreased (1000 and 1,600,000/$mm^3$, respectively). Sternal puncture showed an excess of monocytoblasts in bone marrow. Abdominal radiographs showed the presence of opacities in the spleen, a picture typical for thorotrastosis of the spleen and lymph nodes. Autopsy showed hemorrhagic lesions in various organs, and microscopically $ThO_2$ particles were detected. Autoradiography of spleen sections confirmed the presence of Th on the basis of $\alpha$-particle tracks. In 1953 the patient had undergone thorotrast arteriography for a diagnostic study of subarachnoid bleeding. (BBB)

**29857** A STUDY ON THE INCIDENCE OF LEUKEMIA DEVELOPING AFTER THERAPEUTIC IRRADIATION FOR CANCER OF BREAST AND UTERUS. Mayeda, Kazuho (Tokyo Univ.); Miyata, Hisatoshi. Nippon Igaku Hoshasen Gakkai Zasshi, 28: 1122-33(Nov. 1968). (In Japanese).

Statistical methods used for estimating the incidence of leukemia in man following radiotherapy of neoplasms of the breast or uterus are discussed. (NSA of Japan) (TSS)

**29858** A CASE OF ACUTE RADIATION INJURY. Kobayashi, Shinichi; Sakai, Kunio (Niigata Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 28: 1137-42(Nov. 1968). (In Japanese).

A case of acute radiation injury is reported that occurred in a 23-year old Japanese man who received about 1,000 to 4,000 R of soft x radiation of 40 KV over his left hand during occupational work with x ray fluorescent analysis equipment. Early erythema appeared at about 14 hr after exposure, edema on the first to second day, and blisters at the fourth day. On the 14th day the most severe local skin reaction, consisting of third degree dermatitis, edematous changes, and ulcerative process, was seen and on the 21st day a tendency to recovery had appeared. By the 45th day after the exposure the area was cured, with a slight scar. During the entire clinical course the patient was in good general condition without any positive laboratory findings. In this case the skin reaction appeared earlier and progress more rapidly than was expected, but tendency to recovery also appeared earlier, which may be caused by the fact that the exposure was to soft x ray. (NSA of Japan) (TSS)

**29859** THREE-YEAR EXPERIENCE OF BETATRON THERAPY. 3rd REPORT. SKIN CHANGES IN ELECTRON BEAM IRRADIATION. Matsuda, Takayoshi; Ikeda, Hiroshi (Toyohashi City Hospital, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1494-1500(Feb. 1968). (In Japanese).

Skin changes were studied in 276 cases treated by electron beam using the Siemens 18 MeV betatron since July 1963. Results were summarized as follows: Although there is a moderate variation in the relation between radiation dose given and reactive erythema and pigmentation, generally, slight erythema and pigmentation resulted after irradiation of 2000 to 3000 R. Moderate changes were seen over 3880 R. Moist reaction occurred after irradiation of 4400 R in children under the age of 10 years, and after 5000 R in adults. Moist dermatitis was seen in all cases given 5500 R over the perineal, head, and axillary regions. Except for cases given electron beam over the three portions described above, 46 percent of 185 patients given 5500 R had complained of moist dermatitis, and moist reaction was seen in 66.7 percent of patients given 6600 R. From a comparative study of cases with dry and moist dermatitis, it is concluded that, the larger the field size and the higher the energy of electron beam, the more frequent the moist desquamative reaction. Moist changes were repaired 7 to 14 days after the completion of radiotherapy in 69.2 percent, and 15 to 21 days in 30.8 percent. Of 128 cases given 5500 to 6600 R and traced over one year no changes were recognized in 19 of 128, slight pigmentation was noted in 28 cases, and moderate pigmentation was seen in 81 patients, and depigmentation was seen in 29, teleangiectasis in 12, and fibrous thickening of the skin in 11 cases. (NSA of Japan) (auth)

**29860** INFLUENCE OF AGE AND UV ON THE POPULATIONS OF DOPA-POSITIVE MELANOCYTES IN HUMAN SKIN. Quevedo, W. C. Jr.; Szabo, G.; Virks, J. (Brown Univ., Providence). J. Invest. Dermatol., 52: 287-90(Mar. 1969).

A group of adult Caucasian males ranging in age from 27 to 65 was exposed frequently over a two week period to uv. The treatment was restricted to the skin of the left or right buttock which tanned significantly during the period of treatment. Counts of dopa-reactive epidermal melanocytes in sheets of epidermis from the buttocks revealed that in non-irradiated skin, great variation in dopa-reactivity and a decline in melanocyte numbers which was significantly correlated with advancing age, approximately 20% per 10 years of life in the age group examined. More uniform dopa-reactivity in the epidermal melanocytes of irradiated skin and a significant increase in their numbers at all ages were observed. (auth)

**29861** DENTAL PROSTHESES AND RADIATION TO THE JAWS: A SURVEY OF PROSTHODONTISTS AND RADIOTHERAPISTS. Elzay, Richard P. (Medical Coll. of Virginia, Richmond); King, E. Richard; Dettman, Prentiss. J. Amer. Dent., Ass., 77: 856-63(Oct. 1968).

Results of a survey regarding the effects of radiation on the jaws reveal the present trend of thinking among and between prosthodontists and radiotherapists. Responses to the 12 questions asked members of both groups are discussed. A questionnaire was mailed to prosthodontists of the American Board of Prosthodontics and to therapeutic radiologists of the American Society of Therapeutic Radiologists. There appeared to be poor communication between the two professional groups. Most prosthodontists and radiotherapists think that patients can wear dental appliances after irradiation if mucous membranes are healthy and appliances are carefully made. A fourth of each group saw osteoradionecrosis induced by dentures. The majority of both groups thought that some or all teeth should be extracted at some time, and most thought that extractions should precede irradiation. The majority of the prosthodontists thought that it was not possible to make a denture that would not sometime produce trauma to the oral mucosa. The majority of both groups agreed that decrease of saliva caused post-therapy problems with the teeth. Most radiotherapists thought that there was a distinct advantage in treating patients with intraoral cancer with megavoltage radiation. (BBB)

**29862** SOME STATISTICAL VIEWPOINTS IN THE STUDY OF CARCINOGENESIS. Mantel, N. (National Cancer Inst., Bethesda, Md.). Progr. Exp. Tumor Res., 11: 431-43(1969).

Statistical aspects of studies on carcinogenic effects of radionuclide ingestion and exposure to other agents are reviewed. During the period of nuclear testing in the atmosphere, a matter of concern was the extent to which such testing resulted in food contamination with consequent ingestion of radionuclides by humans. Some statistical aspects of the problem are considered. It was concluded that emphasis should be placed on keeping radionuclide levels in food low rather than in keeping low the number of individuals receiving excessive exposure. The two contrasting approaches are viewed in terms of the shape of a dose-response curve, some measure of average damage to an individual vs the arithmetic dose yielding average damage. (BBB)

**29863** PRENATAL RADIOINJURY WITH PARTICULAR REFERENCE TO DIAGNOSTIC X-RAY PROCEDURES. Gefferth, Karl (Univ. Medical School, Budapest). Roentgen Bl., 20: 592-7(Dec. 1967). (In German).

Effects of prenatal x irradiation on infants and children are classified and discussed briefly. The effects vary as to whether the irradiation takes place before or after fertilization. Irradiation before fertilization produces somatic effects in the immediate offspring, such as developmental anomalies or death. Genetic effects are similar, but usually delayed until later generations. Irradiation after fertilization may produce developmental anomalies of the central nervous system, or development of leukemia or malignant tumors during childhood. Organogenesis may be affected and various developmental anomalies of different organs may appear. Effects of irradiation may differ as to whether irradiation is administered during the preimplantation phase, during organogenesis, or during the later fetal period. Although the general types of injuries produced by prenatal irradiation are known, the extent of irradiation damage is less known. (BBB)

**29864** THE SKIN. Goldman, Leon (Univ. of Cincinnati). Arch. Environ. Health, 18: 434-6(Mar. 1969).

The effects of lasers on animals and humans are discussed and the following conclusions were made. Skin exposure must be considered as part of the occupational hazards of the laser. The acute burn may be either through intent, or accident, or as part of the laser casualty. Chronic exposure, as well as increased reactivity to lasers from repeated exposures, should continue to be studied. Laser personnel records should include such data as skin type, exposure to sun areas involved, dryness, pigmentation, keratoses, examination under Wood's light, color photography, and, when indicated, biopsy studies. (C.O.)

**29865** BIOLOGICAL EFFECTS AND POSSIBLE HAZARDS OF VERY HIGH FREQUENCY RADIATION FROM RADAR AERIALS. Joly, R. Arch. Mal. Prof. Med. Trav. Secur. Sociale, 29: 121-30(Mar. 1968). (In French).

After recapitulating the technique characteristics and thermal effects of radar on man (influence of amount of energy absorbed, the radiation wave-length and internal and external heat regulation) biological and pathological consequences of these thermal effects are discussed: lethal action, and effect on eyes, certain endocrine glands and the nervous system. The specific effects of intermittent electromagnetic fields and secondary effects of microheating are

still debatable. Safety measures applied in the USA and USSR are outlined and the view is expressed that the French authorities might profit from their example. (Occup. Safety and Health Abstr.)

**29866** EFFECT OF IONIZING RADIATION ON THE DEVELOPMENT OF THE FETUS. Hlavaty, V.; Blekta, M.; Graf, M. (Charles Univ., Prague). Cesk. Gynekol., 33: 84-7(Feb. 1968). (In Czech).

The possibility of the irradiation damage to the embryofetus is the greatest in the first trimester of pregnancy, especially in the first 6 weeks of pregnancy, and it is, to a great extent, dependent on the individual radiosensitivity of the embryo. The most frequent iatrogenic risk is involved in therapeutic interventions in the abdominal region and the minor pelvis of pregnant women. To prevent such events it is necessary to postpone the indicated radiation interventions to the second half of pregnancy and to use the shield amplifiers of the picture, scintillation detectors and so on. (auth)

**29867** RADIATION HAZARD FROM CHEST X RAYS. Kenney, Gordon N. (Presbyterian Medical Center, Denver). Rocky Mt. Med. J., 65: 34-5(Oct. 1968).

A typical chest x-ray will expose the subject's skin at the point of beam entrance to ~10 mR. Since the radiation beam reduces in intensity rapidly as it passes through the body, exposure received in the area where the beam passes out of the body will be ~1 mR. The dose received by gonads will usually be less than 1 mR since they are not in the direct x-ray beam. Thus, maximum exposure is ~10 mR for a chest x ray. To place this exposure in perspective, it is compared with other radiation exposures. An exposure of 50,000 to 75,000 mR is usually required to the whole body before any effect is noticeable by the individual or before any effect can be detected by medical examination. For example, an x-ray of the ankle requires ~150 mR, while a lateral x-ray of the pelvis will require ~3000 mR. Cosmic radiation contributes ~35 mR/yr to each individual at sea level. However, this amount increases with altitude so that people living at a high altitude may receive ~75 mR per year from this source. Terrestrial radiation, i.e., that from radioactivity in air, food, houses, etc., contributes ~50 mR/yr. Finally, fallout produces 5 mR/yr. A typical dental x-ray produces an entrance exposure of from 500 to 3000 mR. These figures clearly indicate that the amount of radiation involved in a chest x-ray is certainly very small and is much less than is received from background, from other types of x rays, or from intentional exposure as received by radiation workers. (BBB)

**29868** MONDOR PHLEBITIS AS A RESULT OF X IRRADIATION. Theisen, H. (Johannes-Gutenberg-Univ., Mainz). Med. Welt, 18: 378-9(Feb. 18, 1967).

Characteristics are described of a case of Mondor phlebitis that appeared after an irradiation dose of 6000 R was given in 20 exposures by a 30-Ci $^{60}$Co source as postoperative treatment for an excised melanoma located on the back. It was preceded by erythema that appeared midway during the irradiation series. The skin became corded and hardened for 20 cm distance, but there was relatively little additional change in skin color. The skin was somewhat protruded and furrowed. The patient experienced some feeling of tension in the affected area. The corded formation regressed after 10 days treatment with a heparinoid salve. (BBB)

**29869** NUCLEAR RADIATIONS AND HEALTH. Singh, Tarlok. Sci. Rep., 5: 443-6(Sept. 1968).

The health hazards posed by ionizing radiation are described. The major types of radiation hazards, their biochemical and physiological effects, maximum permissible dose rates under various conditions of exposure, precautionary and protective measures, and therapy are also described. (Arms Contr. Disarmament)

**29870** AVERSION TO DENTAL X RAYS: LET'S REVERSE THE TREND. O'Brien, Richard C. (Ohio State Univ., Columbus). Dent. Clin. N. Amer., 657-62(Nov. 1968).

Hazards attendant to dental radiography are reviewed, and the problem of convincing patients of their minor nature is discussed. During radiography of the patient's oral tissues a minute amount of radiation registers its effect on the reproductive cells via secondary radiation. This is ~1/10,000 of the amount of specific-area radiation delivered to the oral tissues. With female patients there would be only 1/3 to 1/7 of this amount because of internal location of their reproductive organs. With a properly controlled unit and with the most sensitive film possible, a routine full-mouth examination would expose the patient to ~5 to 6 R (65 kVp, 10 mA). This would be specific-area radiation delivered to the face, of which ~0.0005 R of x radiation would reach the reproductive cells of the male. It is estimated that 0.0004 R/day is received by reproductive cells from background radiation. Thus a patient's reproductive tissues receive radiation from a full-mouth examination in amounts slightly higher than that from daily background radiation. Definite improvements have been made in x-ray procedures, to a point where patients may receive only 5 to 6 R per full-mouth examination. Most of this reduction can be attributed to the development of highly sensitive films, although proper filtration and smaller beam collimators have also contributed. (BBB)

**29871** ABSOLUTE BASOPHIL COUNT IN CANCER OF THE UTERINE CERVIX. Tuncer, Mustapha; Graham, John B. (Roswell Park Memorial Inst., Buffalo). Obstet. Gynecol., 29: 386-9 (Mar. 1967).

A study of circulating basophils during treatment of women with cervical cancer showed that the number of basophils apparently is reduced by radiotherapy. Doses of x rays and Ra given to each patient are listed. Ten patients were treated primarily with external x radiation. Of these four had basopenia initially; in three it persisted and in 1 it increased in association with pelvic infection. There were 2 with a high count initially, both of whom showed a decrease. There were four with a normal count. In two of the latter the count was unchanged and in two it decreased. Of the nine patients treated initially with Ra, five showed a decrease in basophils after irradiation. The concentration of mast cells adjacent to the tumor in a pretreatment biopsy specimen was evaluated in 23 patients. Many mast cells were found in 4 of 7 patients with basopenia, 4 of 11 with normal basophils, and in only 1 of 5 with basophilia. The decrease of basophils following irradiation is compatible with the earlier observation that radiotherapy increases the concentration of mast cells in the irradiated tissue. Many mast cells about the tumor are found more frequently in basopenia. Thus basophils may migrate into the tissue to become mast cells and so deplete the circulating blood. (BBB)

**29872** PATHOLOGICAL STUDIES ON RADIATION PNEUMONITIS OF HUMAN MATERIALS AND EXPERIMENTAL ANIMALS. Tachikawa, Shinzo (Niigata Univ., Japan). Niigata Igakkai Zasshi, 82: 394-417(June 1968). (In Japanese).

Investigations were made on the etiology and pathology of radiation pneumonitis (radioinduced pulmonary fibrosis) following exposure of the chest region to massive doses of $^{60}$Co $\gamma$ or x radiation. Tissues obtained at autopsy from 28 human patients were examined histologically. The etiology of this disease was studied in rats following exposure of the thorax to single or fractionated doses of x radiation. Radiation pneumonitis was observed in the rats with an exudation in lung alveoli resembling that found in human patients. Complications such as pneumonia and tumors were observed in only two of 30 rats that developed pneumonitis. Changes in epithelium of the respiratory tract, characterized by a large number of giant cells, and changes in the cytology of the spleen were observed in tissues from both man and rats. It was concluded that the etiology of radiation pneumonitis is related to changes in allergic responses induced by irradiation. (TSS) (NSA of Japan)

**29873** CHANGES IN THE URETER IN RADIOTHERAPY OF CERVICAL CANCER. Hittmair, A.; Frick, J. (Univ., Innsbruck). Zentralbl. Gynaekol., 89: 1466-71(Oct. 7, 1967). (In German).

Combination therapy with radium and x ray was performed on 262 patients with carcinoma of the cervix. Of these, 28 showed abnormal urinary excretion patterns. One year after radiotherapy, 141 patients were reexamined urographically. In 26 cases pathological changes were found; eleven of these existed already prior to radiation, eleven were caused by metastases, and four were probably radioinduced. Emphasized is the importance of urological examination during the course of radiotherapy. (H.B.G.)

**29874** FURTHER STUDIES OF LATE LESIONS FOLLOWING DERMATOLOGIC RADIOTHERAPY. Kopp, H.; Reymann, F. (Finseninstitutes, Copenhagen). Z. Haut-Geschlechtskr., 42: 349-54(May 1967). (In German).

The results of a study of patients who 20 years previously had been treated with radium, thorium X in alcohol solution, and radium emanation in wax plates for various dermatoses were reported. It was possible to study well 80% of the patients. The radium-treated patients had been treated for foot warts. Scars were found in 31.7% of the patients who had received one treatment and in 87.5% of the patients with two treatments. The number of patients with subjective complaints because of the scars were 7.7 and 85.7% for one and two radium treatments, respectively. Ulcerations of malign tumors were not found. The use of radium for the treatment of mild dermatoses was suspended about 1955 because of the large number of complications. Thorium X and radium emanation are used for dermatoses such as pityriasis

and psoriasis. In the latter study of about 100 patients no evidence of radiation damage was found. (tr-auth)

**29875** PATHOGENESIS OF CHANGES IN THE BLOOD SYSTEM IN ACUTE RADIATION SICKNESS. Baisogolov, G. D. (Inst. of Medical Radiology, Moscow). Med. Radiol., 14: No. 5, 19-26(May 1969). (In Russian).

On the basis of analysis of experimental data and personal clinical observations the author arrives at the conclusion on the role of disturbances of cellular division in the development of cytopenia in a typical form of acute radiation sickness (total irradiation dose — 100–1000 rad). In the process of regeneration after total irradiation the main importance is attached to proliferation and intensified differentiation of reticular cells into blood cells. In the proliferation of reticular elements there is a potential hazard of leukemia development. The absence of such a marked proliferation of reticular cells in local irradiation explains the sharp reduction of the leukomogenic effect of radiation in experiments with screening of separate areas of the hematopoietic tissue. (auth)

**29876** CUTANEOUS REACTIONS AFTER RADIATION THERAPY. REPORT OF 7 CASES. Maxfield, William S.; Coleman, William P. (Ochsner Clinic and Oschner Foundation Hospital, New Orleans). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 636-43(Mar. 1969).

Erythema multiforme as a reaction to irradiation is a distinct clinical entity. We have been able to find reports of 47 previous cases and have added 7 cases of cutaneous reactions after radiation therapy. Two developed after orthovoltage and 5 after telecobalt-60 therapy. Treatment should include temporary cessation of irradiation, use of topical medications, administration of antihistamines, and systemic administration of corticosteroids if the eruption and systemic symptoms are severe enough to warrant this form of treatment. (auth)

**29877** CLINICO-THERAPEUTIC CONSIDERATIONS OF A DELAYED CASE OF OSTEORADIONECROSIS OF THE MANDIBLE. (17 YEARS AFTER IRRADIATION). Carnelutti, S.; Mairo, F. (Univ., Genoa). Stomatologica (Genoa), 12: 1-21 (Dec. 31, 1967). (In Italian).

After a brief examination of the etiological, anatomic-pathological, radiological problem, and the clinical picture of the mandibular radionecroses, a case in consequence of the extraction of a tooth seventeen years after radiotherapy is related. Owing to the seriousness and extent of the osteoradionecrotic process, the resection of the affected mandibular branch was necessary. As the therapeutic possibilities of such lesions are poor, it is considered necessary to carry out all the prophylactic measures apt to eliminate all the elements that might produce lesions in patients who need irradiation. When it is necessary to extract a tooth in an area previously irradiated that has not undergone a convenient preparation, the importance of subjecting the patients to an antibiotic therapy, protracted till the alveolar mucous membrane is cured, is emphasized in order to diminish the dangers of a delayed osteoradionecrosis. (C.O.)

**29878** STUDIES ON THE EFFECT OF MICROWAVES ON THE EYE. Majewska, Kalina Klin. Oczna, 38: 323-8(1968). (In Polish).

Two groups of two hundred persons each were examined. The first group consisted of workers subjected to the influence of microwaves, 2.8 to 50 cm of length. The second group was a control one of the same age bracket, having no connection with microwaves. Results of investigations statistically analyzed showed that there exists a possibility of injurious influence of microwaves, even in the range of intensity admitted by security regulations, if their action lasted a sufficiently long time (above 4–5 years). (auth)

**29879** CHANGES IN FACE AND HEAD AFTER X-RAY RADIATION IN CHILDREN. Manko-Jasek, Czeslawa; Kuenstler, Lucylla. Czas. Stomatol., 21: 683-90(June 1968). (In Polish).

Observations of severe malformations in face and head caused by x radiation are described. Two rare cases in which mothers-to-be were exposed to x rays while working in the examination laboratories are cited. Their new-born children had severe malformations such as an oblique cleft of the face and dysostosis mandibulo-facialis unilateralis. The results of x radiation in children for hemangioma of the face are reported. Damage of the growing centers leading to underdevelopment of skin and bones was stated. These appear during maturation. Asymmetry of the face caused by x radiotherapy or by a combination treatment of x rays, surgery, and electrocoagulation is reported. Caution is emphasized in the use of x rays in children. (H.B.G.)

**29880** BLADDER COMPLICATIONS FOLLOWING RADIOTHERAPY OF CERVICAL CARCINOMA. Hittmair, A. (Univ., Innsbruck). Wien. Med. Wochenschr., 117: 710-13(July 29, 1967). (In German).

In a series of 250 patients with carcinoma of the cervix, the incidence of severe bladder complications is studied. In addition to the gamma radiation dose, bacterial infections apparently play the most important role for the occurrence of ulcerations. The course of 14 patients with such alterations is reported. Generally, conservative treatment, often throughout a long period of time, is favorable. (H.B.G.)

**29881** RADIATION DAMAGE TO THE GROWING HUMAN ORGANISM. Grimm, J.; Hempel, H.-C. Arch. Kinderheilk, 176: 127-33(1967). (In German).

Radiation-induced abnormalities of development of two male infants whose mothers had received deep x-ray therapy during pregnancy are reported. Therapy was performed on one during the third month for a lymphogranulomatosis and on the other during the sixth month for a rethotel sarcoma of the vagina. The symptoms of the fetal damage are particularly characterized by microcephaly and disturbances in the maturation of hematopoiesis. (auth)

**29882** COMPLICATIONS IN THE UPPER EFFERENT URINARY TRACT AFTER SUCCESSFULLY TREATED FEMALE GENITAL CARCINOMA. Fischer, Klaus-Peter (Martin-Luther-Univ., Halle-Wittenberg, Ger.). Wiss. Z. Martin-Luther-Univ. Halle-Wittenberg, Math.-Naturwiss. Reihe, 16: 477-92(1967). (In German).

Out of 190 gynecological tumor patients who were clinically free of recurrences, between ages 23 and 71 yr, 40 developed urological injuries of the upper urinary tract after x irradiation with a dose of 3600 R. The dose was fractionated into two series four weeks apart. Each single dose was 200 R. Some of the patients were also treated with 6000 R or less of contact irradiation from implants given at two week or four week intervals. Hydronephrosis affected the right side more frequently than the left. (BBB)

**29883** THROMBOEMBOLI OF THE LUNGS AS A SEVERE EARLY COMPLICATION OF GYNECOLOGICAL CONTACT CURIE THERAPY. A CONTRIBUTION TO PRIMARY MORBIDITY AND MORTALITY. Koenig, Hartmut (Martin-Luther-Univ., Halle-Wittenberg, Ger.). Wiss. Z. Martin-Luther-Univ. Halle-Wittenberg, Math.-Naturwiss. Reihe, 16: 463-75(1967). (In German).

Early complications of gynecological contact radiotherapy can be defined as those effects that appear within six or eight weeks after treatment. These include vulvitis, colpitis, pyometria, endometritis, parametritis, adnexitis, localized and diffuse peritonitis, fever, coronary insufficiency, myocardial infarction, cardiocirculatory failure, bronchopneumonia, proctitis, colitis, and enteritis, phlebothrombosis, thrombophlebitis, pulmonary thromboembolism, and ascending urinary tract infections. Out of 1268 patients 18.7% developed early complications. Most of these consisted of fever, proctitis and enteritis, thromboemboli, and cardiovascular diseases. Pelveoperitonitis, thrombosis, severe hemorrhage, diffuse peritonitis, and pyometria were also observed but in fewer numbers. Most of the early complications developed after the first irradiation treatment, or after irradiation lasting more than 20 hr. Inflammatory complications were less frequent in patients over 70 yr of age than in younger patients. Noninflammatory, predominantly cardiovascular and thromboembolic, complications prevailed in patients 50 yr of age. Pulmonary embolism was the most frequent fatal complication observed. Degenerative vascular disease and tumors were found frequently. To prevent pulmonary emboli as much as possible, circulation should be prompted mechanically at an early time after irradiation, implantation time should be less than 20 hr, anticoagulation therapy should be administered, and irradiation of patients in poor physical condition or with metastasized tumors should be avoided. (BBB)

**29884** RADIATION INDUCED NEOPLASIA FOLLOWING EXTERNAL BEAM THERAPY FOR CHILDREN WITH RETINOBLASTOMA. Sagerman, Robert H.; Cassady, J. Robert; Tretter, Patricia; Ellsworth, Robert M. (Columbia-Presbyterian Medical Center, New York). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 529-35(Mar. 1969).

Radiation-induced neoplasia was assessed in a uniform population — children treated with irradiation for retinoblastoma. The incidence of radiation-induced neoplasia varied with dose, and is estimated to be approximately 1.5 per cent with current techniques (megavoltage, 3,500 rads in 18 to 20 days, treatment three times a week). There was no direct correlation of dose with latent period. (auth)

**29885** INJURY TO THE FETUS BY RADIATION. Scherer, [E]. Landarzt, 43: 328-9(Mar. 10, 1967). (In German).

Radiation injury to the fetus can be shown by malformation of the fetus, higher incidence of leukemia in children after exposure of the mother during pregnancy, and actual genetic damage caused by injury of the spermiogenesis. The damage to the fetus requires higher doses than generally assumed. Data relating to the leukemia incidence and genetic damage are summarized from previous studies. (J.S.R.)

**29886** CHANGES IN THE NERVOUS SYSTEM IN OCCUPATIONAL EFFECT OF IONIZING RADIATION. Barabanova, A. V.; Guskova, A. K.; Kirsanova, G. I.; Losev, A. A. (Inst. of Sanitation and Occupational Disease, Moscow). Med. Radiol., 14: No. 4, 69-74(Apr. 1969). (In Russian).

A literature survey dedicated to the clinico-physiological characteristics of separate phases in the development of the clinical syndrome of the nervous system reaction to occupational irradiation is presented. Information is given on the threshold values of single and total doses of occupational irradiation in which there is a significant intensification of functional shifts of the nervous activity. An analysis is presented on the principles of using and adequacy of different methodological investigations of the nervous system in patients of the occupational group. An evaluation of the relative risk of irradiation of the nervous system in confrontation with other organs and tissues is also given. (auth)

**29887** CHANGES OF MARROW HAEMATOPOIESIS UNDER THE INFLUENCE OF IONIZING RADIATION AND CHEMICAL SUBSTANCES USED IN COMBATING MALIGNANT TUMORS AGAINST THE BACKGROUND OF MAGNETIC FIELD USAGE. Chachava, K. V.; Charkviani, L. I.; Zhgenti, T. G.; Kintraya, P. Ya.; Nishnianidze, K. A.; Lominadze, A. A.; Chachava, I. K. (Inst. of Genecology, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 53: 425-8(Feb. 1969). (In Russian).

To abolish leucopenia, developed as a result of treatment of malignant neoplasms with ionizing radiation and chemicals, hemostimulation was used with the help of alternating magnetic field. Ninety white rats were used for the experiments. Aggravation of leucopenia was registered with all the animals: from 1000 to 5200 units in 1 $mm^3$ of blood, while growth of leucocytes in the control group was registered only in 35% of cases: from 300 to 1130 units in 1 $mm^3$. Positive results were also obtained in clinical conditions where among 20 patients, due to discontinued radiotherapy because of the onset of severe leucopenia, 18 were able to continue the course of specific treatment. The findings of the study led to the assumption that magnetic field has a stimulating effect on leucopeisis resulting from radio- and chemotherapy of malignant tumors. The method is economical and easy to apply in any type of treatment, including dispensary. (auth)

**29888** RADIOTHERAPY OF THYMIC TUMORS IN MYASTHENIA GRAVIS. Skeggs, David B. L. (Royal Free Hospital, London). Proc. Roy. Soc. Med., 61: 760-2(Aug. 1968).

The effect of radiotherapy, including complications of irradiation of the thymus, in myasthenia gravis is presented. Thymic tumors show the characteristic presence of lymphatic tissue, which exhibits a high degree of radiosensitivity. Cases of thymic tumors disappearing after doses as low as 1500 rad are due to the response of the lymphatic element of the tumor. The epithelial cells of the tumor do not display this same degree of radiosensitivity and doses of 5000 to 6000 rad are necessary to ensure their elimination. However, the mediastinum does not tolerate high dosage irradiation well, and 6000 rad given to the necessarily large volume to be treated in the mediastinum may result in an intolerably high morbidity rate. Radiation-induced pneumonitis may accompany large-volume irradiation of lung, especially after a high dose. In the presence of infection this may progress to pulmonary fibrosis. Patients with myasthenia gravis have an inherent liability to chest infections which makes this complication all the more serious. Radiation-induced mediastinitis is a serious complication. It can be the heralding sign of irradiation pericarditis. The question of radiation carditis is discussed. Cardiac complications have seldom been reported when doses as high as 5000 to 6000 rad have been received by the heart. It is unusual for radiation pneumonitis to develop during treatment and it is most commonly seen about 4 to 6 weeks after treatment is completed. Breathing exercises are given daily and a chest infection should be treated by an appropriate antibiotic until the completion of the radiotherapy. (BBB)

**29889** EPITHELIOMATA AFTER RADIOTHERAPY OF THE SPINE. Meara, R. H. Brit. J. Dermatol., 80: 620(Sept. 1968).

To supplement an earlier report of Sarkany, et al. (Brit. J. Dermatol., 80: 90(1068)) of multiple basal cell epitheliomas following radiotherapy, additional cases are briefly reported. It is suggested that such an occurrence is not as rare as proposed by Sarkany, et al. One additional patient showed all the features they described, including the premalignant fibroepithelioma (Pinkus) as well as multiple basal cell epitheliomas. The case report was not previously published. Since that time 5 other patients have been seen, 2 of which also showed fibroepitheliomas; they are still under surveillance. None of these patients shows any signs of radiodermatitis in the affected areas. No other data are given. (BBB)

**29890** RESULTS OF PRELIMINARY STUDIES AND EVALUATION OF CRYSTALLINE LENS TRANSPARENCY IN PERSONS SUBJECTED TO THE INFLUENCE OF MICROWAVES. Zydecki, Stanislaw. Klin. Oczna, 38: 31-3(1968). (In Polish).

Results of examinations of lens transparency in 500 persons exposed to the influence of microwaves and compared with examinations of 500 persons of a control group are discussed and presented in tables. Attention is called to the fact that microwave radiation hastens the aging of lenses. The unification of examination methods and of the definition of lens transparency and vocational ability is proposed and discussed. (auth)

**29891** ISOTOPE MEASUREMENT OF THE EFFECT OF MICROWAVE IRRADIATION UPON CAPILLARY CIRCULATION IN STRIATED MUSCLES OF EXTREMITIES. Gorski, S.; Kwasniewska-Blaszczyk, M.; Mackiewicz, S.; Ramlau, D. (Inst. for Balneoclimatology, Poznan, Poland. Medical Academy, Poznan, Poland). Pol. Med. J., 7: 736-41(1968).

Translated from Pol. Tyg. Lek., 22: No. 25(1967).

In 30 human subjects, the capillary blood flow in gastrocnemius muscle exposed to microwave radiation was determined by means of radioisotope clearance. The experiments have shown that microwave radiation induces hyperemia or ischemia of the irradiated area. In individual cases, a complete absence of reaction was noted. The results suggest that microwave treatment requires a previous determination of individual reactivity and spatial distribution of the reaction in the patients under study. (auth)

**29892** RADIOINDUCED SARCOMA OF THE SKULL. Friedmann, Gerhard; Kleinsasser, Oskar (Univ., Cologne). Strahlentherapie, 137: 33-7(Jan. 1969). (In German).

The author presents four cases of post irradiation fibrosarcomas after treatment of malignant tumors (1 ependymoma, 1 spongioblastoma, 1 cylindrome and one spindle cell carcinoma). These tumors were histologically confirmed. The prognosis must be considered as bad. Irradiation of the region of the surgical scar after complete removal of a benign cerebral tumor must be prohibited, in view of the possible genesis of sarcomas. The risk should be considered in non-certain benign tumors. If it is shown that the osteoradionecrosis is a preliminary step in the genesis of a fibrosarcoma, the excision of radiologically demonstrated fibrotic lesions in the bone should be considered, in order to prevent sarcomatous transformation. (auth)

**29893** EFFECT OF SHORT-WAVE IRRADIATION OF THE LIVER ON THE ELIMINATION OF BROMSULPHALEIN IN LIVER DISEASES. Fusy, J.; Ihasz, Mihaly; Refi, Miklos. Orv. Hetil., 108: 1026-8(Oct. 22, 1967). (In Hungarian).

Following earlier studies on the effects of short-wave irradiation on the functions of the liver, the elimination of the bromosulfalein (BSP) dye was investigated. One of the groups of patients was also subjected to pathological tests. A Siemens apparatus was used to irradiate the patients who were injected with BSP intravenously within one min after exposure. The results indicated that patients suffering from reduced function of the liver greatly increased the rate of removal of BSP; the concentration of BSP was 11% lower with respect to the control group after three min; after 15 min, the three min value was further reduced by 30.9%. The irradiation caused a noticeable, also lesser reduction of the BSP in patients suffering from cirrhosis of the liver. On the basis of data obtained with 20 patients, the use of short-wave irradiation is recommended for the treatment of patients suffering from impairment of liver function. (TTT)

## Radiation Effects on Plants

*Refer also to abstracts 28737, 29344, 29346, 29373, 29428, 29433, 29437, 29438, 29441–29443, 29445–29448, 29452–29454, 29715, 29717, 29911, and 29944.*

**29894** (COO-1625-26) MITOTIC CYCLES IN MERISTEMS. Davidson, D. (Case-Western Reserve Univ., Cleveland, Ohio). Feb. 1969. Contract AT(11-1)-1625. 37p. Dep. CFSTI.

The duration of the phases of the cell cycle was measured in Vicia faba lateral roots using $^3$H-thymidine as the tracer. The

effects of indole acetic acid (IAA) and colchicine on the cell cycle time and the effects of colchicine on the development of primordia were also studied. Data are included on the cytology of developing primordia of primary roots. Whole roots treated with 0.003 to 0.05% solutions of colchicine for three hours developed tumors. The cytology of lateral roots emerging from the tumors was studied. The synthesis of DNA in diploid and tetraploid root cells with and without IAA treatment was measured using $^{3}H$-thymidine as the tracer. The effects of colchicine on the morphology of plants of Nicotiana glauca-langsdorffii, an amphidiploid that naturally produces tumors when flowering occurs, were also studied. Whole root systems of Vicia faba were exposed to 50, 100, and 150 rads x radiation and up to eight hours later were treated with colchicine for two hours. Chromosome aberrations and mitotic indexes were scored for cells fixed at various times following irradiation. Preliminary results suggest that primordia are less sensitive to x radiation than fully emerged and growing lateral roots. (C.H.)

**29895** (NYO-3998-1) ANNUAL PROGRESS REPORT [ON LETHAL SECTORING AND APPARENT INTERCHROMOSOMAL EFFECTS IN YEAST]. (Brooklyn Coll., N. Y.). [1968]. Contract AT(30-1)-3998. 5p. Dep. CFSTI.

Pooled haploid budding lethal sector data showed highly enhanced recombination after x irradiation; however, when each of the individual clones was analyzed, normal map distance was observed. Studies to elucidate the mechanism of radioresistance of yeast are briefly described; in one area, mutations deficient for budding cell resistance were sought using a variety of mutagens. Six mutants were found. The medium in which overnight refrigeration occurred and the medium upon which poststorage budding occurred were found to be important. If stored overnight in water at 8°C prior to exposure to growth conditions, the resulting budding cells were found to be of the same sensitivity as the interdivisional cells. All budding cells were indistinguishable on the basis of the Feulgen reaction; all showed the same evidence of DNA increase in their nuclei thus indicating that DNA increase of itself was insufficient to confer radioresistance. Azure B staining results indicated that DNA duplication and RNA synthesis were both required for radioresistance in budding yeast. (C.O.)

**29896** ESTIMATION OF ABSORBED DOSES OF γ-IRRADIATION IN SMALL-SIZED GLOBULAR HYDROBIONTS. Parchevskaya, D. S. (Inst. of Biology of Southern Seas, Sevastopol, USSR). Radiobiologiya, 9: 281-5(1969). (In Russian).

Graphical dependences of the absorbed doses of γ-radiations in globular small-sized hydrobionts upon the parameters characterizing the emitters and the geometrical conditions were obtained. (auth)

**29897** APICAL DOMINANCE AND REGENERATION IN VEGETATING PLANTS AFTER γ-IRRADIATION. Grodzinskii, D. M.; Gudkov, I. N. (Inst. of Plant Physiology, Kiev). Radiobiologiya, 9: 249-56(1969). (In Russian).

It was shown that apical dominance increases the ability of plants for postradiation recovery on account of the regeneration of shoots from the axillary buds, distinguished by comparatively high radioresistance. Gamma irradiation in doses reaching a definite critical value removes apical dominance. In this case the rate of recovery processes at doses to some degree exceeding this critical value may be higher than at doses that do not reach it. (auth)

**29898** RESTORATION OF RADIATION DAMAGES TO COTTON SEEDS UNDER THE ACTION OF HIGH TEMPERATURE. Berezina, N. M.; Narimanov, A. A. (Inst. of Biological Physics, Moscow). Radiobiologiya, 9: 262-5(1969). (In Russian).

The postradiation heating of cotton seeds of the 108-f variety, irradiated at an inhibiting dose of 40 kR, which removes the injurious effect of this dose and promotes restoration of viability of the heated seeds, was studied. The optimum system of heating was established at 70°C for 48 hrs. Plants with a decelerated rate of development at the initial stages of ontogenesis, with deformed leaves, a changed color, and abnormal branching, grew out of the irradiated heated seeds. The morphological changes were almost restored by the time of budding; however, the plants lagged behind the controls in rates of growth and development, and in yield of crude cotton. Seedlings from unheated irradiated seeds died at the stage of the cotyledon leaves. The biochemical and physiological changes induced by irradiation were restored by postradiation heating of cotton seeds. (auth)

**29899** BIOLOGICAL EFFECTS OF OXIDATION PRODUCTS OF VARIOUS PHENOLS AT THE ANODE (ON THE THEORY OF FORMATION OF RADIOTOXINS). Fomenko, B. S.; Fomenko, L. A.; Kuzin, A. M. (Inst. of Biological Physics, Pushchino on the Oka, USSR). Radiobiologiya, 9: 319-21(1969). (In Russian).

The effects of oxidation products of various phenolic compounds, widespread in plants, at the anode upon the growth of Escherichia coli were studied. Substantial toxicity of free radicals of phenols containing an amino group (tyrosine, phenylalanine, and 3,4-dihydroxyphenylalanine) was detected. The radiosensitive family of legumes contained more of these substances than representatives of more radioresistant families. (auth)

**29900** ON THE OCCURRENCE OF GAMMA RAY INDUCED ACCESSORY OVULES IN COLEUS BLUMEI BENTH. Hillson, C. J.; Baker, J. E. (Pennsylvania State Univ., University Park). Radiat. Bot., 8: 407-13(Dec. 1968).

The occurrence of flowers having accessory ovules on the inflorescences of irradiated Coleus plants was investigated. Plants having no visible inflorescences, immature inflorescences, and inflorescences with open flowers were irradiated with a cesium-137 γ source for 25 hr at a dosage of 200 R/hr. The number of flowers having accessory ovules, cyme numbers in which they occurred, and the length of time between their appearance and the opening of the first flower on the inflorescence were recorded. The early formed cymes of the recovery period produced more flowers with accessory ovules than did later developing cymes. The flowers were produced for several weeks following the opening of the first flower, but there was a steady decline in number with time. Plants with mature inflorescences at the time of irradiation and nonirradiated control plants produced no flowers with accessory ovules. Increased stigmatic areas were associated with the number and the occurrence of accessory ovules, suggesting an increase in carpel number. (auth) (UK)

**29901** EXPERIMENTAL EXAMINATIONS ON THE BIOLOGICAL EFFECT OF THE LASER RAY. Mester, Endre; Nagy, Eva J.; Elekes, Istvan; Tota, Jolan G. Magy. Radiol., 21: 49-55 (Feb. 1969). (In Hungarian).

The effect of the non-focussed laser radiation in para-synchronic cultures of Saccharomyces cerevisiae has been examined by the authors. The stimulant and the impeding effects, respectively, of the radiation have been examined, observing the variation of the rapidity of the proliferation and the reproduction, the variation of the oxygen uptake; these variations have been compared with those produced by x radiation under identical circumstances. (auth)

**29902** INVESTIGATIONS ON THE INTERACTION OF REACTOR RADIATION AND GROWTH SUBSTANCES ON SUMMER BARLEY. Levinsky, H.; Haunold, E. (Reaktrozentrums, Seibersdorf, Austria). Bodenkultur, 18: 141-6(May 1967). (In German).

Air dried seeds of summer barley Quantum were irradiated in the reactor with doses that caused a marked growth inhibition. Subsequent application of gibberellic acid during the first three weeks of development could partly or totally compensate the irradiation effect of growth inhibition. Treatments using kinetin increased the growth inhibition of irradiation even more. (auth)

**29903** DECAY OF THE RADIATION EFFECT ON NITELLA AT REPEATED IRRADIATION COMPARED WITH THE INFLUENCE ON THE MECHANISM OF EXCITATION. Hansen, Ulf-Peter (Institut fuer Angewandte Physik, Kiel). Atomkernenergie, 14: 207-10(May-June 1969). (In German).

Irradiation of internodal cells of Nitella fl. causes a transient depolarization of the resting potential or a transient inward current when the membrane is clamped to resting potential. The radiation effect decreases as the irradiation is repeated. Evidence is made that it is not possible to explain this decay of the radiation effect by damage of that mechanism controlling the membrane permeability during an action potential. This result has been obtained by comparing the currents caused by irradiation and by a depolarising voltage clamp step (40 mV). Voltage clamp with external electrodes has been used throughout the experiments. (auth)

**29904** INFLUENCE OF WATER CONTENT OF BARLEY SEEDS DURING IRRADIATION ON THE GROWTH OF THE SEEDLINGS. Joshi, R. K.; Ledoux, L. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Arch. Int. Physiol. Biochim., 77: 156-7 (Feb. 1969). (In French).

Radiosensitivity of seeds, as seen by plant germination, seems to depend on their water content, and is decreased to minimal levels at about 10% water. Radiosensitivity increased with lower or higher water contents, suggesting a relation with the metabolic activity of the grain. Attempts were made to verify this. Different parameters were varied in 4-day embryos, showing that changes in the dose of radiation and humidity for a given dose caused significant changes in dry wt and in the DNA, RNA, and protein content of the stem and roots of the seedlings. DNA and RNA decreased in the stalk, while in roots only RNA decreased. Protein levels fell in both parts. Changes in the endosperm were opposite to those in the developing

organs. These changes were minimal for seeds irradiated at 10% humidity. In 1-day embryos effects of irradiation and humidity were much less than in 4-day embryos. Acid RNAase and DNAase were not affected under these conditions. These results are in accord with previous findings, and show that metabolic processes involving the nucleic acids and proteins are highly radiosensitive. (BBB)

## Radiation Effects on Microorganisms

*Refer also to abstracts 29307, 29308, 29395, 29403, 29436, 29438, 29451, 29458, 29896, 29917, 29925–29927, 29930, 29935, and 29943.*

**29905** (ORO-3347-7) PHYSIOLOGICAL STUDIES ON CLOSTRIDIUM BOTULINUM, TYPE F. Progress Report, December 1, 1967–February 28, 1969. Walls, Nancy W. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract AT-(40-1)-3347. 9p. Dep. CFSTI.

The radiosensitivity of Clostridium botulinum Type F was compared to that of Type E in spore stocks γ-irradiated in phosphate buffer, nutrient gelatin, and fish homogenate media. Proteolytic enzyme complement of the organism was a more significant factor in radioresistance than was the immunological type. Nonproteolytic strains of Type F exhibited radiation survival patterns like those of Type E, while survival of proteolytic types was comparable to that of immunologic Types A and B. (H.G.D.)

**29906** (SAN-733-2) EFFECT OF CONTINUOUS GAMMA IRRADIATION ON GROWTH OF VIRUSES IN TISSUE CULTURE SYSTEMS. Progress Report, May 15, 1968–May 14, 1969. Boche, Robert D. (Loma Linda Univ., Calif.). Feb. 13, 1969. Contract AT(04-3)-733. 21p. Dep. CFSTI.

The $^{137}Cs$ irradiator has been assembled and the radiation field within the incubator carefully calibrated. Because of the long half life of $^{137}Cs$, the facility should have a considerable period of usefulness. The Multibeta irradiator described last year has been calibrated in absolute terms by ferrous sulfate dosimetry and some instructive experiments performed with it. Additional data from experiments with $^{137}Cs$ or $^{90}Sr-^{90}Y$ irradiation and then inoculation of myxovirus (influenza $A_2$) have been accumulated that suggest the problem of demonstrating differences between growth characteristics of influenza virus in irradiated and nonirradiated cell cultures is clearly related to only slight differences most frequently in favor of better growth in the irradiated cultures. Moreover, the ability to demonstrate these differences is directly related to how closely the end-point is examined and how heavily the cells are irradiated. Interferon determinations show no differences in irradiated and nonirradiated cell culture systems. Simultaneous irradiation and infection resulted in decreased growth of virus. The mechanisms involved will be explored. A mathematical method devised previously for obtaining the maximum likelihood estimate of plaque and colony counts is presented in Appendix A. A computer program in Fortran language for obtaining the probabilities as given by the Poisson Distribution is sometimes useful in plaque counting and provides, in addition to the individual probabilities, the sum of any desired number of terms. This program is presented in Appendix B. (C.O.)

**29907** ACTION SPECTRUM FOR GROWTH DELAY INDUCED IN ESCHERICHIA COLI B/r BY FAR-ULTRAVIOLET RADIATION. Takebe, Hiraku; Jagger, John (Southwest Center for Advanced Studies, Dallas). J. Bacteriol., 98: 677-82(May 1969).

An action spectrum for growth delay induced in Escherichia coli B/r by far-ultraviolet radiation (230 to 295 nm) was obtained. It resembles the action spectrum for killing obtained in the same experiments, indicating that the chromophore for growth delay is probably the same as the chromophore for killing. Another action spectrum for killing, obtained under conditions more suitable for chromophore identification, suggests that nucleic acid, either deoxyribonucleic acid or ribonucleic acid, is the chromophore for growth delay induced by far ultraviolet. Isoprenoid quinones, which seem to be important chromophores for growth delay induced by near-ultraviolet radiation (above 300 nm), appear to play a negligible role in growth delay induced by wavelengths below 300 nm. (auth)

**29908** INFLUENCE OF THE MEDIUM AND THE STOCK ON THE ROLE OF NATURAL RADIATION IN DROSOPHILA MELANOGASTER. Planel, Hubert; Soliehavoup, Jean-Pierre; Giess, Marie-Claude (Faculte de Medecine, Toulouse). Compt. Rend., Ser. D, 268: 584-7(Jan. 20, 1969). (In French).

The effect of the culture media on the radiosensitivity of different strains of Drosophila melanogaster, cultivated either on classic medium or sterile David medium, was studied. The radiosensitive Oregon strain raised on classic medium had an increase of the embryonic development shown by a lower proportion of offspring with imagos on the first day of hatching with respect to control offspring. A comparable result was found with David medium. The offspring of wild strain on classic or David medium shows a behavior comparable to that of the Oregon strain. A delay of pupa hatching appears with the cross-breeding of Ebony and Sepia. The hatching began on the 10th day for radiosensitive offspring, whereas 32% of the control offspring already had adults of the first generation. These results are discussed. (J.S.R.)

**29909** ULTRAVIOLET INACTIVATION OF THE CYTOCIDAL AND TRANSFORMING ACTIVITIES OF HUMAN ADENOVIRUS TYPE 1. Finklestein, Jerry Z.; McAllister, Robert M. (Childrens Hospital of Los Angeles, Calif.). J. Virol., 3: 353-4(Mar. 1969).

The size of the human adenovirus type 1 (Ad-1) viral genome required for plaque formation was compared with that required for focus formation. By use of uv irradiation the inactivation curves of the plaque-forming and the focus-forming abilities of the virus were determined. Earlier studies of uv-irradiated human Ad-12 indicated that the virus adsorbs to KB cells and uncoats normally; they also indicated that the target size of T-antigen production and of virus-induced chromosome aberrations is 25% of the target size for plaque formation. The virus was irradiated at a distance of 6.4 cm with a model R-51 lamp. The dose rate of irradiation at 253.7 nm was $1.98 \times 10^3$ erg/min/mm$^2$. The curve for focus formation, apart from an initial shoulder, appeared to obey single-hit kinetics. The curve for plaque formation showed a very slow inactivation after 4 min, presumably as a result of multiplicity reactivation. These data suggest that the transforming activity of Ad-1 is more resistant to uv irradiation than is the plaque-forming activity and therefore requires less of the virus genome. Evidence is presented that virus multiplicity reactivation was not responsible for the increased survival of the transforming activity. (BBB)

**29910** UV-INACTIVATION OF THE COLICINOGENIC FACTOR E1 INCORPORATED INTO THE TRANSDUCING PARTICLES OF THE PHAGE P22. Likhoded, V. G.; Blinkova, L. P. (Mechnikov Research Inst. of Vaccines and Sera, Moscow). Genetika, 5: No. 5, 123-8(May 1969). (In Russian).

The transduction of the chromosome markers and colicinogenic factor E1 by the uv-irradiated P22 lysates in Salmonella typhimurium is studied. It is shown that the curves, describing the dependence of the complete transduction of the try and leu markers on the doses of uv-rays, are of the multifit type. The colicinogenic factor and the genome of the P22 phage were inactivated exponentially. The comparison of the slopes of the inactivation curves shows that the E1 factor contains about $1.10^4$ nucleotide pairs, which is four times less than the genome of P22. (auth)

**29911** PROCEDURE FOR EVALUATING THE EFFECTS OF 2,450-MEGAHERTZ MICROWAVES UPON STREPTOCOCCUS FAECALIS AND SACCHAROMYCES CEREVISIAE. Lechowich, R. V.; Beuchat, L. R.; Fox, K. L.; Webster, F. H. (Michigan State Univ., East Lansing). Appl. Microbiol., 17: 106-10(Jan. 1969).

Modifications of a commercial 2,450-megahertz microwave oven were made so that 6 ml of microbial suspension could be exposed to the microwave field for various periods of time. The microorganisms were contained in the central tube of a modified Liebig condenser positioned in the approximate geometric center of the oven cavity. Kerosene at −25C was circulated through the jacket of the condenser during microwave exposure permitting microwaves to reach the microbial suspension. Flow rates of the kerosene were varied to permit the temperature of the suspension to range from 25 to 55C during microwave exposure. Conductive heating experiments using similar temperatures were also conducted. A thermocouple-relay system was employed to measure the suspension temperature immediately after the magnetron shutoff. Continuous application of microwaves to suspensions of $10^8$ to $10^9$ Streptococcus faecalis or Saccharomyces cerevisiae per ml appeared to produce no lethal effects other than those produced by heat. Respiration rates of microwave-exposed S. cerevisiae were directly related to decreases in viable count produced by increased microwave exposure times. (auth)

**29912** EFFECT OF ULTRAVIOLET IRRADIATION AND HEATING ON HUMAN ADENOVIRUSES. Pusztai, Rozalia; Beladi, Ilona; Bakay, Marta; Mucsi, Ilona (Univ. Medical School, Szeged, Hungary). J. Gen. Virol., 4: 169-76(Mar. 1969).

A comparison was made of the effect of heat inactivation and uv irradiation upon the ability of adenoviruses to induce interferon. The source of uv light was a Hanau germicidal lamp. Virus samples

were irradiated with a uv dose of 15.5 erg/mm²/sec. After heating adenovirus type 12 for different times both the infectivity and the interferon-inducing capacity of the virus were reduced. Treatment for 2 min at 56°C completely abolished the interferon-inducing capacity and caused a 4-log reduction in the infectivity. Infectivity and interferon-inducing capacity were tested before and after uv irradiation of adenovirus type 12. Interferon induction by the virus was much less sensitive to irradiation than infectivity. At uv doses completely abolishing infectivity, considerable inductive capacity remained. Interferon formation by chick cells inoculated with both uv-irradiated and heated adenovirus type 8 was also studied. The results obtained were similar to those observed with type 12. The possibility that the penton antigen may be responsible for interferon induction by human adenoviruses in chick cells is discussed. (BBB)

**29913** INACTIVATION OF CANDIDA ALBICANS BY ULTRAVIOLET RADIATION. Busbee, David L.; Sarachek, Alvin (Wichita State Univ., Kansas). Arch. Mikrobiol., 64: 289-314 (Jan. 30, 1969).

Inactivation of Candida albicans by uv irradiation (2537Å) was shown to be greatly dependent upon the cell division stage, the nutrition, and the growth temperatures of cells both before and after irradiation. Cells grown at 37°C after uv irradiation showed lower survivals than those grown at 25°C. At either recovery temperature, cells that were cultured before irradiation at 37°C sustained less uv damage prior to inactivation than those cultured at 25°C. The poor recovery by irradiated nonbudding cells at 37°C was correlated with their transitory filamentation when initiating growth at that temperature. Neither the filamentous growth per se nor the temporary inhibition of cell division associated with filamentation caused the poor recovery. Furthermore, while irradiated nonbudding cells at 37°C exhibit singular susceptibility to inhibition of recovery by metabolic antagonists which disturb protein synthesis, the course of their filamentous growth is not affected by such agents. It was concluded that recovery from irradiation and the instigation of cytokinesis by nonbudding cells of C. albicans result from different metabolic processes that may be related through a common temperature-sensitive step. C. albicans does not photoreactivate and lacks a system for dark repair of DNA damage comparable to that occurring in bacteria. (BBB)

**29914** VIRUCIDAL EFFECT OF TRANSIENT ELECTRIC ARCS IN AQUEOUS SYSTEMS. Singh, M. P.; Hermodsson, S.; Edebo, L. (Univ. of Uppsala). Appl. Microbiol., 17: 54-8 (Jan. 1969).

Bacterial and animal viruses were inactivated by high voltage electrical discharges in water. The sensitivity of phages to the immediate component of this effect was correlated to the sensitivity to ultraviolet radiation. Transient electrical arcs in weak electrolytes also generated chemical compounds which were virucidal against phages T3, T5, and φX174 but were only slightly virucidal against phages T2 and T4. (auth)

**29915** EFFECTS ON GROWTH AND TOXIN PRODUCTION OF EXPOSURE OF SPORES OF CLOSTRIDIUM BOTULINUM TYPE F TO SUBLETHAL DOSES OF GAMMA IRRADIATION. Williams-Walls, N. J. (Georgia Inst. of Tech., Atlanta). Contract AT-(40-1)-3347. Appl. Microbiol., 17: 128-34(Jan. 1969).

Spores of the Langeland strain of Clostridium botulinum type F were grown at 30 or 10C after exposure to 0.0, 0.1, or 0.2 Mrad of cesium-137 gamma irradiation. When incubated at 30C, cultures irradiated at the 0.2 Mrad level reached the stationary growth phase 15 hr earlier than the 0.0 or 0.1 Mrad-irradiated cultures. This was not the result of earlier or more frequent germination of the irradiated spores, the formation of larger individual cells, filament formation, or cell clumping. It appeared to result from elimination of a lytic phenomenon noted in 0.0 and 0.1 Mrad-irradiated cultures after 26 and 29 hr of incubation, respectively, which was followed by a second exponential growth response 5 hr later in these cultures. The time of toxin appearance in culture supernatant fractions was independent of prior irradiation treatment and occurred after 36 hr of incubation. Toxin release was essentially logarithmic until maximal titers were reached and maximal toxin titers were higher in irradiated than in unirradiated cultures. The higher toxin level was sustained over a period of 23 days at 30C. Toxin produced in the 30C cultures could not be trypsin-activated. An incubation temperature of 10C resulted in no outgrowth of spores subjected to 0.2 megarad of irradiation, although spore germination did occur. At 10C, outgrowth of the 0.1-megarad culture was faster with slightly higher quantities of a more stable toxin than was seen in the unirradiated control. At 10C, trypsinization was necessary to demonstrate the toxin present in the cultures. (auth)

# Radiosterilization and Radiopreservation

*Refer also to abstracts 29346, 29477, 29724, 29726, and 29943.*

**29916** (CONF-670649-27) PRESERVATION OF FOODS BY IRRADIATION. VI. PRELIMINARY INVESTIGATIONS ON STRAWBERRIES. Garcia de Mateos Lopez, A.; Rivas Garcia, A.; Ortin Sune, N.; del Val Cob, M. (Junta de Energia Nuclear, Madrid (Spain)). [1967]. 21p. (In Spanish). Dep.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

The results of the preliminary studies on the radiation preservation of strawberries are presented. The parameters studied were percentage weight loss, external aspects (particularly brilliance and color), softening, microbe development, variations in ascorbic acid content, and estimation of the commercial parameters. The results showed that irradiation at 200 to 250 krad prolongs the storage period by 3 to 4 days. The strawberries irradiated at 200 to 250 krad are acceptable commercially up to 15 to 20 days from the viewpoint of microbe development. The variation of the ascorbic acid content as a result of irradiation has no nutritional importance. (tr-auth)

**29917** (MIT-3325-22) THE EFFECT OF GAMMA RAYS ON HADDOCK AND CLAMS INOCULATED WITH CLOSTRIDIUM BOTULINUM, TYPE E. Progress Report, 1965. Goldblith, S. A.; Nickerson, J. T. R. (Massachusetts Inst. of Tech., Cambridge). Feb. 1969. Contract AT(30-1)-3325. 63p. Dep. CFSTI.

The effects of cobalt-60 γ irradiation on growth and toxin production by Clostridium botulinum type E in clams and haddock were investigated. After haddock was inoculated with $10^2$ to $10^6$ spores per g and/or irradiated with 150 to 350 Krad, they were held at various temperatures for different time periods before testing for toxin production. No toxins were present in samples stored as long as three times the irradiated storage life at temperatures below 40°F. Samples inoculated with only 100 spores per g and stored at 45°C did not become toxic in three times the storage life, but a $10^4$ spore inoculum was toxic if kept at 45°C longer than two times the storage life. All samples inoculated with $10^6$ spores per g became toxic within the normal irradiated storage life. The level of contamination with type E Clostridium botulinum in uninoculated haddock fillets was 17 or less cells per 100 g. Haddock juice had an inhibiting effect on Clostridium botulinum spores and a detoxifying effect on the toxin. The temperatures attained during deep fat frying of fillets were high enough to inactivate the toxin. The bacteria usually causing spoilage of unirradiated haddock were found to facilitate growth and toxin production by Clostridium botulinum. Since radiopasteurization largely destroys these bacteria, it may, therefore, increase the safety of haddock fillets as far as botulism is concerned. Commercially prepared clams were found to have two or less cells per 100 g. (M.M.B.)

**29918** (NP-17850) USE OF IRRADIATION TECHNIQUES FOR DECONTAMINATION OF FEED GRAINS. Working Document No. 87. (European Atomic Energy Community, Brussels (Belgium). Bureau Eurisotop). [1968]. 11p. (In French). Dep.

Summary of discussions of working group of Bureau Eurisotop in meetings of January 11, 1967 and March 4, 1968.

In spite of progress in the fields of general hygiene and the hygiene of food preparation, the incidence of food intoxications has increased since 1940. The organism chiefly responsible for the food intoxication is a salmonella. The role of cattle and poultry in food poisoning is discussed. Decontamination of forage by industrial processes is discussed. Salmonellae and other pathogenic agents are eliminated by chemical, thermal, and pelletization treatments. Radiation techniques for decontamination of flour and fish and other forage mixtures are described. A general logarithmic reduction of salmonellae in forage is caused by a 0.5 MRad dose of γ radiation; this process is called radicidation. For effective radicidation of forage mixtures it is necessary to determine initial contamination by salmonellae, to continue hygienic surveillance in all stages of production, and to establish the absence of all species of enterobacteria in a gram of irradiated product. A pilot test program for radicidation of forage was submitted to the European Community; this included assay of nutrition of pork fed irradiated food, control of growth of animals, and studies on physiological and pathological effects. The test program also included studies on the quality of forage before and after irradiation and multiplication of salmonellae in pork. Preliminary irradiations are carried out to determine the minimum dose necessary

for eliminating salmonellae and other enterobacteria for effective decontamination. Experimental procedures for dose determinations are described. (H.L.W.)

**29919** (NYO-3989-1) INVESTIGATIONS ON STERILIZATION BY IRRADIATION FOR THE CONTROL OF THE SOUTH-AMERICAN FRUIT FLY, ANASTREPHA FRATERCULUS (WIED.). Progress Report. Gonzalez Bachini, Juan E. (Research Experimental Agricola de la Molina, Lima (Peru)). Mar. 31, 1969. Contract AT(30-1)-3989. 50p. Dep. CFSTI.

Laboratory and field studies were conducted to determine the biology of Anastrepha fraterculus. Data concerning the life cycle and its reproductive habits were obtained. Three irradiation experiments were conducted to determine the necessary doses of $\gamma$ radiation to induce sexual sterilization. Following irradiation at doses of 6,000 to 10,000 R, male pupas showed no reduction in copulating activity, but a highly significant reduction in the number of viable eggs laid was obtained in the 8,000 and 10,000 R groups. A series of experiments were conducted to determine the effects of irradiation on competition with normal populations. In the first experiment, four competition levels were tested (50:1, 30:1, 10:1, 1:1) following irradiation of the test couples at 8,000 R. It was determined that levels of 50:1 and 30:1 of sterilized males to normal were capable of frustrating the fertilizing possibilities of the eggs laid by the females mated with them. In the second experiment, it was shown that ratios of 50:1 and 30:1 were successful at radiation doses of 6,000 or 8,000 R in regards to cessation of egg laying and mortality rate. Statistics on the extent of the fruit production industry in the valley of Ica, the number of spoiled fruits involving Anestrepha species, and a brief resume of trapping procedures are presented. (E.R.B.)

**29920** (ORNL-tr-2142) PRESERVATION OF FOOD BY IRRADIATION. VII. STUDIES ON SPANISH POTATOES, ALAVA, AND GINEKE VARIETIES. Garcia de Mateos Lopez, A.; Rivas Garcia, A.; Ortin Sune, N.; del Val Cob, M. (Junta de Energia Nuclear, Madrid (Spain). Seccion de Isotopos). Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from report JEN-189-SI/I-18. 13p. Dep. CFSTI.

From the results obtained, and based on doses received by the different lots, an 8 krad dose of radiation was considered adequate for sprout inhibition in stored potatoes. This dose was not so important a parameter to commercial interests as was the weight loss or shrinkage suffered by the tubers thus stored. In six months' storage, weight losses in the 8 krad batches were 7.8% as compared to 15.3% in the controls. After nine months' storage, the values were 26.6 and 50.3%, respectively. An 8 krad dose was best for decreasing the incidence of rot during the experiment. The values were 4% for the irradiated potatoes and 10% for the controls. There were no appreciable changes in texture of the 8 krad batches, and the turgidity remained commercially acceptable. The ascorbic acid content of the tubers was not affected by an 8 krad dose, and after five months' storage it was greater than initial values, in contrast to nonirradiated lots, in which values were very low at this time. Total- and reducing-sugar determinations further showed that irradiation of potatoes to prevent sprouting in storage is a good process. After four months' storage no "sweetening" of the potatoes was noted. In animal tests, the 8 krad potatoes showed no significant differences from the control with respect to edibility, animal weight increase, protein digestibility coefficient, fat-digestibility coefficient, metabolizable energy, net calorie intake, and growth-efficiency coefficient. The single decrease found was in connection with total digestible nutrients and net energy per kilogram of dry weight. However, irradiation at this dose significantly increased the digestibility of the dry material as well as of the nitrogen-free extracts. (auth)

**29921** (ORNL-tr-3005) INHIBITION OF POTATO SPROUTING BY GAMMA IRRADIATION: CONDITIONS, EFFECTS, AND FEASIBILITY. Sandret, F.; Michiels, L. Translated for Oak Ridge National Lab., Tenn., from Ind. Aliment. Agr. (Paris), 93: 1189-99(1966). 15p. Dep. CFSTI.

The characteristics of ionizing radiation are summarized, and the results of a study of the physiology of $\gamma$ irradiated potato tubers (Bintje and Kerpondy varieties) are reported. Besides sprout inhibition, an increase in respiration and a transitory rise in soluble sugar content, chiefly sucrose, were observed. In long-term experiments, no further physiological changes were observed. Despite the absence of sprouting, soluble sugars accumulated progressively corresponding to incubation phenomenons. Extensive experimentation indicated the feasibility of the treatment and the wholesomeness of irradiated tubers. Details on the state of the work at the time of writing and on future prospects are given. (auth)

**29922** (RISO-122) MICROBIOLOGICAL CONTROL OF RADIATION STERILIZATION OF MEDICAL SUPPLIES. I. TOTAL COUNT ON MEDICAL PRODUCTS (DISPOSABLE SYRINGES AND DONOR SETS) PRIOR TO RADIATION STERILIZATION. Christensen, Ebbe Ahrensburg; Mukherji, S.; Holm, Niels W. (Danish Atomic Energy Commission, Risoe. Research Establishment). Aug. 1968. 25p. Dep.

A technique for determination of the number of micro-organisms on dry disposable equipment prior to radiosterilization is described. A total of 1678 hypodermic syringes from the same producer were investigated. The average count for the period of investigation was calculated to be in the range of 3.5–10.8 per syringe. Only nine syringes, i.e., 0.54% of the samples, gave off more than 100 organisms. The highest single count was 294 (obtained from a 20 cc syringe). A total of 297 donor sets from another producer were investigated. The average counts in the individual batches varied between 0.3 and 61 organisms per sample. The highest single counts were 800 and 840. The relations applied at Risö between initial counts on the products and the minimum doses used for radiosterilization are described. Products such as the syringes referred to above were irradiated with a minimum dose of 3.5 Mrads. Equipment for blood banks, such as the donor sets, was irradiated with a minimum dose of 4.5 Mrads. These relations are based on agreements with the health authorities. (Denmark)

**29923** (SORIN-92) PRESERVATION OF SEVERAL FOODSTUFFS OF ANIMAL ORIGIN. Denti, E. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). 1966. 19p. (In Italian). Dep.

A brief review is presented of the factors involved in the radiosterilization of meats. The discussion includes: the principal causes of alterations in meat, radiation doses required for inactivation of bacteria in meat, the effects of radiosterilization on the storage life of meat, radiation doses required to bring about different levels of preservation in meat, the effects of irradiation on lipids and volatile components of meat, and the effects of low temperature irradiation on the organoleptic properties of meat. It was concluded that after years of research and the expenditure of millions of dollars, irradiated foods are safe for consumption and acceptable nutritionally. (E.R.B.)

**29924** (SPR-20) EFFECTS OF IRRADIATION ON THE VOLATILE COMPONENTS OF FRUIT JUICES. I. FIRST RESULTS FROM APPLE AND GRAPE JUICES. Barrera, R.; de la Cruz, F.; Gasco, L.; Manero, J. (National Centre for Nuclear Energy, Madrid (Spain)). Nov. 1967. 125p. Dep.

Analytical methods were tested and the selected chromatographic method and conditions are described. Gamma irradiation (cobalt-60) at doses higher than about 0.5 Mrad of Austrian apple and grape juices yielded acetaldehyde, the concentration of this compound increasing proportionally with dose. Irradiation of grape juice formed in addition 2-methyl-2-butanol, also proportional to dose. In the apple juice irradiated at doses higher than 1.6 Mrad, a marked decrease of the 2-hexanal peak was observed. This peak also diminished in the deep-frozen stored juice. Finally, irradiated grape juice showed an enhancement of the peak corresponding to acetone (or ethyl formate). Irradiation of Spanish apple juice at doses ranging from 0–2.5 Mrad produced no noticeable changes in the aromagrams. Aqueous aroma concentrates from Spanish apple juice irradiated at 0.5–3.5 Mrad showed only a continuing reduction of an unidentified peak (possibly, valeraldehyde, n-propanol, propyl acetate, or 2-methyl-2-butanol). Irradiation of previously de-aromatized apple juice at doses up to 3.7 Mrads yielded 10 volatile compounds, all of them identified in the fresh juice. A literature survey on the chemical composition of aromas is included in the report. (57 References). (C.O.)

**29925** (TID-24882) GROWTH AND TOXIN PRODUCTION OF CLOSTRIDIUM BOTULINUM TYPES E, NONPROTEOLYTIC B, AND F IN NONIRRADIATED AND IRRADIATED FISHERIES PRODUCTS IN THE TEMPERATURE RANGE OF 38° TO 50°F. Final Summary. Eklund, M. W.; Poysky, F. T. (Bureau of Commercial Fisheries, Seattle, Wash. Technological Lab.). July 1968. Contract AT(49-7)-2442. 70p. Dep. CFSTI.

Growth times and toxin production by Clostridium botulinum type E were measured following inoculation of spores into packs of nonirradiated and $\gamma$-irradiated (100 or 200 Krad) haddock, petrale, and sole fillets during storage at temperatures ranging from 38 to 50°F. Data are included on the effects of radiation dose, spore concentration and source of the inoculum, fish species, and storage time and temperature on the outgrowth time of the spores and toxin titers. Sediment samples were collected from marine and freshwater areas, and the occurrence of various types of C. botulinum at different depths of the core was determined. Mitomycin C was found to be an excellent agent for activating or inducing lysis in actively growing cultures of C. botulinum.

Bacteriophages for different types of C. botulinum were found in cell lysates. (C.H.)

**29926** (TID-24883) THE SIGNIFICANCE OF CLOSTRIDIUM BOTULINUM TYPE E IN THE APPLICATION OF RADIATION-PASTEURIZATION PROCESS TO PACIFIC CRAB MEAT AND FLOUNDER. Final Summary. Eklund, M. W.; Poysky, F. T.; Wieler, D. I. (Bureau of Commercial Fisheries, Washington, D. C. Technological Lab.). July 1966. Contract AT(49-7)-2442. 90p. Dep. CFSTI.

Methods of determining the incidence of Clostridium botulinum Type E from natural sources have been investigated. A comparison of incubation time at 30°C for determining the incidence of Cl. botulinum in enrichment cultures has shown that the largest number of samples containing botulinum toxins will be obtained by assaying enrichment cultures after 3 days. Longer periods of incubation at this temperature resulted in the loss of toxicity in most of the samples. A comparison of incubation temperatures for determining the incidence of Cl. botulinum in marine sediments has shown that 91% of the enrichment cultures incubated at 25°C contained Type E toxin whereas only 69% of the samples incubated at 30°C contained Type E toxin. The largest number of toxic cultures was obtained when 5 gram plantings of marine sediments were made. Peptone, trypticase, beef-infusion egg-yolk agar was found to be the best solid substrate for the isolation of Type E from enrichment cultures. The production of a pearly layer by Type E colonies on this medium serves as an excellent means of differentiating Cl. botulinum from the other clostridia. The only solid medium from which we were able to isolate Type F and nonproteolytic Type B was peptone, trypticase, beef-infusion egg-yolk agar fortified with yeast extract and 0.1% sodium thioglycollate. The addition of 1% yeast extract to the enrichment medium has enabled us to subculture Type F and nonproteolytic Type B from crude enrichment cultures. Prior to this finding we were unable to subculture either Type B or F from enrichment cultures of marine samples. (C.O.)

**29927** (TID-24885) THE EFFECT OF GAMMA RAYS ON HADDOCK AND CLAMS INOCULATED WITH CLOSTRIDIUM BOTULINUM, TYPE E. Period Covered: January 1, 1964–December 31, 1964. Nickerson, John T. R.; Goldblith, Samuel A. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nutrition and Food Science). Feb. 1969. Contract AT(30-1)-3325. 62p. Dep. CFSTI.

The effects of $^{60}$Co $\gamma$ irradiation on growth and toxin production by Clostridium botulinum in clams and haddock were investigated. After the products were inoculated with $10^2$ to $10^8$ spores per g and/or irradiated with doses of 150 to 800 Krad, they were held at various temperatures and tested for growth and toxin production by clostridia. All of the inoculated clams irradiated or unirradiated exhibited growth and toxin production when held at 40 or 45°F, but Clostridium was inhibited by temperatures of 35°F or below. No uninoculated clams, either irradiated or unirradiated, showed evidence of toxin production. The tests on haddock were not completed, but the preliminary results were similar to those with clams. Since uninoculated clams did not exhibit toxin production under any conditions, radiopasteurization of these products is not considered to be a public health hazard. (M.M.B.)

**29928** GAMMA IRRADIATION FOR VEGETABLE STORAGE: POTATO TUBERS. Patil, J. A. (College of Agriculture, Poona). Parbhani Agr. Coll. Mag., 7: 22-4(Dec. 1965).

Norin No. 1 potato tubers were irradiated with $\gamma$ rays at the beginning of the sprouting period with total dosage varying from 5,000 to 50,000 R. A dosage of 20,000 R and higher completely inhibited sprouting and tubers were in a fairly good firm condition externally at the end of 12 weeks storage period. There was no difference in internal rating. Irradiation prolonged the storage life and reduced shrinkage losses probably caused by sprout control. Potato tuber irradiation offers several potential advantages by suppressing the growth for a long period. (auth)

**29929** A PROCESS FOR THE TREATMENT OF LIQUIDS, MORE PARTICULARLY PRESERVATION THEREOF. (to Osterreichische Studiengesellschaft fur Atomenergie GesmbH). British Patent 1,129,746. Oct. 9, 1968. Priority date June 22, 1965, Austria.

A method is described for the preservation of liquids of all kinds, particularly beverages, in which the liquid is irradiated with $\gamma$ radiation and is also subjected to a physical, physiochemical, and/or chemical treatment. The radiation dose is insufficient for preservation without combination with the other processes; however, the combination of processes results in a product whose organoleptic properties are good. (B.L.M.)

**29930** EFFECT OF GAMMA IRRADIATION ON THE MICROFLORA OF RICE. Iizuka, Hiroshi; Ito, Hitoshi (Tokyo Univ.). Cereal Chim., 45: 503-11(Sept. 1968).

The effects of $^{60}$Co $\gamma$ radiation given at 14 doses ranging from 0.01 to 1.36 Mrad on the microflora and the storage quality of unpolished and polished rice harvested in Japan, and polished rice imported from Spain, were investigated. Chromogenic Pseudomonas and fluorescent Pseudomonas were the main microflora of unirradiated, unpolished or polished Japanese rice. Of microorganisms found on Spanish rice, 20 to 30% are molds; the rest are chromogenic Pseudomonas and fluorescent Pseudomonas. The principal microorganisms of rice which are chiefly responsible for rice damage, including molds such as Penicillium and Aspergillus, can be sterilized with 0.2 to 0.3 Mrad. When rice was irradiated with 0.2 to 1.2 Mrad red Pseudomonas was the main survivor. Radiation-resistant yeasts were isolated from unpolished rice irradiated with 1 Mrad or more. No increase in the number of microorganisms was observed on irradiated rice packed in a polyethylene pouch after storage for 30 days at 10° and 30°C. If the loss of stored rice grain caused by molds such as Penicillium and Aspergillus is a serious problem, radiation pasteurization, e.g., of imported rice, might be promising. (BBB)

**29931** THE STERILIZATION OF FOODSTUFFS BY MEANS OF IRRADIATION. (II). Knop, J. A. H. Pharm. Weekbl., 103: 1227-9(Nov. 8, 1968). (In Dutch).

The question previously raised about the safety of irradiated foodstuffs may be answered by the inquiry of the Food and Drug Administration of the U.S.A. into the safety of the use of bacon sterilized by irradiation. Distribution of irradiated ham was foreseen, and plans are to use irradiated chicken, corned beef, frankfurters, hamburgers, and fish cakes for feeding troops by 1974. In January 1967 FDA withheld approval of irradiated ham. In general, irradiation has shortcomings as a method of sterilization; in 1968 reports of significant effects on the reproductive systems of test animals fed the irradiated ham were published. Influences on mortality, risk of cataracts and tumors, and other vital figures were noted. The earlier statement on bacon is being reviewed, though it was used at 12 military bases in the U.S.A. for two years. Quite different effects may be found for different foods. Irradiation of other foods is also reviewed. (BBB)

**29932** PECTINESTERASE ACTIVITY IN IRRADIATED "VALENCIA" ORANGES. Dennison, R. A.; Ahmed, E. M.; Martin, F. G. (Univ. of Florida, Gainesville). Contract AT (40-1)-3097. Proc. Amer. Soc. Hort. Sci., 91: 163-8(Dec. 1967).

Harvested Valencia oranges were irradiated with 0, 100, 200, and 300 krad of $^{60}$Co $\gamma$ rays and stored at 68°F for 0, 7, and 14 days. Pectinesterase activity (PE) was assayed on the juice expressed by a reamer-type extractor. Irradiation dosage and storage duration influenced the enzyme activity. As the dosage increased, the fresh fruit exhibited higher activity while the reverse was true for the stored fruit. Contours of equal PE activity over the experimental region indicated that; to minimize the PE activity, prolonged storage of fruit irradiated with dosages in excess of 100 krad is required; the PE activity will be maximized with dosages of 100 krad or above for the fresh and short-term stored fruit; and fruit irradiated with about 25 krad would possess the same level of PE activity during the 14 day storage period. (auth)

**29933** THE STERILIZATION OF FOODSTUFFS BY MEANS OF IRRADIATION. Bon, W. F. (Univ. of Amsterdam). Pharm. Weekbl., 103: 1109-10(Oct. 4, 1968). (In Dutch).

There is great economic advantage in the irradiation of bulk foodstuffs for sterilization, but the process raises questions of safety. The mechanism of sterilization may involve the destruction of the nucleic acid processes of the cells of parasites. Perhaps these radiation products are carcinogenic. One of the hypotheses of the initiation of carcinoma in the body is alteration of the nucleic acid mechanism in some cells; the cause of this alteration is uncertain but might be induced by foodstuffs. If this proves to be correct, irradiated foods must be forbidden, because of the possibility of introducing degraded nucleic acids. A commission on the safety of the irradiation process, under the United Nations, should be established; as long as this commission's work is unfinished, a moratorium on industrial applications should be absolute. (BBB)

**29934** EFFECT OF PREIRRADIATION QUALITY OF EVISCERATED HADDOCK ON POSTIRRADIATION SHELFLIFE OF FILLETS. Ampola, V. G.; Ronsivalli, L. J. (Bureau of Commercial Fisheries, Gloucester, Mass). J. Food Sci., 34: 27-30(Jan.-Feb. 1969).

Radiopasteurization is an effective means of preserving haddock

fillets of varying marketable quality. While results show that the postirradiation shelf life was a function of the preirradiation quality, they also indicate that there was an economic benefit from irradiating the fillets cut from fish as old as 13 days after catching. (auth)

**29935** IRRADIATION TREATMENT OF WIENER SAUSAGE WITH GAMMA-RAY. Kosaka, Kazuhisa; Danbara, Hiroshi. Nippon Shokuhin Kogyo Gakkaishi, 15: 507-13(Nov. 1968). (In Japanese).

The effects of γ irradiation on the microorganisms that cause slime or putrefaction, was investigated for the purpose of extending the shelf-life of weiner sausage. Following irradiation of 0.5 Mrad, microbial count in all the products examined was reduced to less than $10^3$/gm, and the products were stored without occurrence of slime or putrefaction for longer period than the unirradiated ones. Such effect of extending shelf-life was especially remarkable on the storage at 2 to 10°C. Of nineteen strains of bacteria, that are often found on meat products, Flavobacterium S-1, Achromobacter lacticum, Bacillus subtilis, and Paracolobacterium aerogeroides survived in cultures after treatment with 0.5 Mrad. (NSA of Japan)

**29936** STUDIES ON MATURATION CHANGES IN FRUITS INDUCED BY IONIZING RADIATION. PART 3. EFFECT OF GAMMA RADIATION ON THE RIPENING AND THE KEEPING QUALITY OF ASTRINGENT PERSSIMON. Ogata, Kuniyasu; Yamanaka, Hiroyuki (Osaka Univ.). Nippon Shokuhin Kogyo Gakkaishi, 15: 519-24(Nov. 1968). (In Japanese).

Persimmons (Diospyros kaki L.) were irradiated at $0.15 \times 10^6$ to $4.0 \times 10^6$ R with γ rays from $^{60}Co$ at the rate of $0.25 \times 10^6$ R/hr. At the doses of $0.15 \times 10^6$ to $0.25 \times 10^6$ R, the fruits ripened three to five days after irradiation, and they became soft and less astringent with the advance of ripening. Tannin content of the ripening fruits decreased considerably following irradiation. For some varieties, the extent of such changes was less at $1.0 \times 10^6$ R than at the lower dose level. The fruits irradiated at $2.0 \times 10^6$ and $4.0 \times 10^6$ R had almost no astringency immediately after irradiation, and they became very soft and darkened. Ascorbic acid content in irradiated fruits decreased during storage. The composition of free amino acids, determined by thin layer chromatography, seemed to be unaffected by irradiation. Carbon dioxide evolution rate of irradiated fruits temporarily increased immmediately after irradiation, and decreased thereafter. This initial increase was proportional to the dose level up to $1.0 \times 10^6$ R. (NSA of Japan)

**29937** THE REPORT ON THE SELECTION OF KIND OF FOOD IRRADIATED AND ON THE ESTABLISHMENT OF THE PUBLIC RESEARCH LABORATORY. Genshiryoku Iinkai Geppo, 13: No. 8, 23-8(Aug. 1968). (In Japanese).

Developments in food irradiation in Japan are reviewed. The economic feasibility of irradiating various foods, depending on production and consumption, and the effectiveness of radiation treatment for extending storage life were investigated. It was concluded that the electron irradiation of wheat, fish paste, weiner sausages, and oranges for the control of spoilage bacteria and insect pests was feasible. The radiation processing of raw fish was investigated. Food irradiation facilities using electron and γ sources are described. Dosimetry studies and studies of the effects of radiation on biochemical and organoleptic properties of foods, the toxicity of irradiated foods, and the combined effects of low temperature and high dose radiation on raw fish and meats are briefly reviewed. (NSA of Japan) (TSS)

**29938** RADIATION TREATMENT OF RICE. PART 1. EFFECT OF CATHODE RAY IRRADIATION ON THE QUALITY CHANGES OF BROWN RICE DURING STORAGE. Umeda, Keiji; Hayakawa, Akira. Nippon Shokuhin Kogyo Gakkaishi, 15: 452-60(Oct. 1968). (In Japanese).

To find the threshold dose level at which flavor change could be detected in cooked rice, organoleptic tests and measurements of cooking quality were conducted on rice treated with various levels of electrons. No significant difference in water absorption, swelling volume, and intensity of iodine-starch coloration of soluble fraction of cooked rice was recognized between control and irradiated samples both immediately and eight months after irradiation up to the dose of 60 Krad. Off-flavor developed immediately after the irradiation of 30 Krad or more, and the rice irradiated at 60 Krad was of disagreeable odor, taste, and appearance. However, after storage of eight months, no significant difference in such characteristics was found among the irradiated samples. Organoleptic quality change by irradiation of 30 Krad became undetectable after storage of four months. By measurement of physical properties of cooked rice with a Texturometer, significant negative correlations were found between the dose level and hardness, and gumminess, respectively. (NSA of Japan)

**29939** CERTAIN SPECIFIC EFFECTS OF ULTRAVIOLET RAYS AND ULTRASOUND ON THE BASIC MICROFLORA OF WINE. Avakyan, B. P. (Armenian Scientific-Research Inst. of Vineyard, Winery, and Fruit Growing). Dokl. Akad. Nauk Arm. SSR, 47: 90-3(1968). (In Russian).

Experiments were carried out on the survival rate of the harmful microorganisms in wine after exposure to the action of ultraviolet light and ultrasonic waves, using samples from various wine-growing regions. The goal of the experiment was development of an efficient cold sterilization method. Pure cultures of Lactobacterium plantarum, Saccharomyces vini, Saccharomyces Ludwigii, Acetobacter vini, Pichia alcoholophila, Candida mycoderma, Torulopsis utilis, and H. apiculta were introduced into the medium which contained malt and agar. It was found that separate action of the ultraviolet radiation and ultrasound exhibited a certain bactericidal effect without deactivating the system completely. Exposure to both agents resulted in complete inactivation, without affecting the chemical composition, such as the concentration of titrable and volatile acids, alcohol, sugar, etc. The proposed treatment of wine increased the amino acids present, probably as the result of the splitting of the wine proteins and peptides. The treatment caused the disappearance of glycolic and the formation of fumaric acid while the concentration of tartric, lactic, and oxalic acids was not affected. The resulting wine was transparent and had a pleasant bouquet and taste. (TTT)

**29940** INCALCULABLE HEALTH RISKS BY FOOD IRRADIATION. Herbst, Walter. Mannheim, Ger., Verlagsgenossenschaft der Waerland-Bewegung EGmbH,[1968]. 31p.

The advantages of irradiation as a method of food preservation are discussed and a history of the food irradiation industry is pre sented. The effects of radiation on preservation of food by sterilization, pasteurization, and by inhibition of metabolism, control of pests and parasites, and hygienic measures to control pathogenic bacteria by irradiation are discussed. Effects of irradiation on the following contents of food are discussed: proteins, amino acids, fats and fatty acids, lipids, carbohydrates, nucleic acids, enzymes, and vitamins. Changes in organoleptic qualities, textural changes, and formation of radiomimetic substances in irradiated foods are described. Effects of irradiated food on the following biological processes are discussed: cell division, mutations, fertility, development of the embryo, digestion, metabolism, and hematological and immunological processes. It is concluded that present knowledge of effects on health after consumption of irradiated food is fragmentary and insufficient for a decision regarding a release of irradiation processes. Legal aspects of food irradiation in the Federal Republic of Germany are discussed. (H.L.W.)

**29941** INACTIVATION OF HUMAN WASTES BY IONIZING RADIATION. Concept and Feasibility. Friedman, M. H. F.; Albrecht, C. Earl (Jefferson Medical Coll., Philadelphia). Arch. Environ. Health, 17: 665-7(Oct. 1968).

From Symposium on Circumpolar Health Related Problems, College, Alaska. See CONF-670715.

Permanently frozen ground, with only the topsoils seasonally freezing and thawing, places severe limitations on sewage disposal in Arctic regions. The possibilities of radiation processing of sewage to sterilize microorganisms are discussed. It is postulated that high speed electrons produced by electrical generators would be the best radiation source for this purpose, since the electrons may be forced, the generator may be turned off when not in use, and extensive safety shielding is not required. (C.H.)

**29942** RADIATION EFFECTS ON PLANT TISSUE. PART I. EFFECTS OF CATHODE RAY ON THE DEHYDRATION OF RAW CARROT AND REHYDRATION OF DRIED CARROT. Umeda, Keiji; Sugawara, Katsunori. Nippon Shokuhin Kogyo Gakkaishi, 16: 15-22(Jan. 1969). (In Japanese).

Radiation treatment caused exponential reduction in the hardness of raw carrot at electron doses from 0.19 to 3.06 Mrad. Regardless of blanching treatment after irradiation, irradiated raw carrot at low doses (0.21 and 0.43 Mrad) showed faster dehydration while at higher doses (0.86 and 1.17 Mrad) slower dehydration than non-irradiated carrot. The water absorption of dried carrot was accelerated by irradiation of raw material with increased dose level. The changes of swelling velocity were determined using an apparatus for the measurement of the total volume decrease by rehydration of dried carrot in the water under reduced pressure at 35°C. The decrease in the total volume and weight of absorbed water may indicate that a greater combination or chemical reaction between water molecules and the micelles takes place in the irradiated dried carrot than in the non-irradiated one. These reactions would cause remarkable decrease of total volume with only a slight acceleration of the swelling of the carrot caused by absorbed water. In both raw and dried carrot, the radiation treatment caused the

decrease of total pectic substances and protopectin and the slight increase of the pectate and the pectin with the increased dose level. No significant differences in flavor and taste after rehydration were detected in irradiated carrot and at the doses of 0.25 and 1.0 Mrad required only one-half to two-thirds of cooking time, respectively, of that necessary for non-irradiated carrot. (NSA of Japan)

**29943** MICROBIOLOGICAL ASPECTS OF FOOD IRRADIATION. Pace, William E. (Atomic Energy Commission, Washington, D. C.). Mil. Med., 134: 215-18(Mar. 1969).

The radiation processing of foods is discussed, with emphasis on doses of electrons, γ, or x radiation required to ensure microbial sterility of the product. It is pointed out that the major concern is the sterilization of Clostridium botulinum spores in fish. The minimum radiation dose required is 4.5 Mrad. Doses of about 500,000 rads are required for the sterilization of Salmonella in poultry. Doses of 20,000 to 40,000 rads are used for reducing bacterial flora that cause spoilage of fruits and for the control of insects infesting grains and some fruits. (C.H.)

**29944** SOME POSSIBLE CONTRIBUTIONS OF RADIOISOTOPES IN MEETING EMERGENT AFRICA'S BASIC NEEDS. Stebbing, J. R. (Culham Labs., Abingdon, Eng.). Isotop. Radiat. Technol., 6: 441-3(Summer 1969). (CLM-P-138).

Some of the grafting points in the general framework of development where radioisotope techniques might most profitably be used are considered. The principal fields considered are: seed improvement, improved use of fertilizers, pest control, grain disinfestation, and groundwater tracing. (auth)

**29945** FOOD PRESERVATION WITH IONIZING RADIATION. Dunham, C. L. Tex. Med., 63: 54-7(Sept. 1967).

Programs of the U. S. Army Quartermaster Corps and U. S. Atomic Energy Commission to investigate food irradiation are outlined. The Army program is designed to eliminate or greatly reduce current refrigeration requirements; to introduce irradiated food items closely resembling fresh items into garrison and combat rations; and to develop flexible, lightweight containers for irradiated food items to gain further logistical advantage. The Atomic Energy Commission program aims to develop radiation-pasteurization techniques which will significantly extend the fresh shelf-life of foods such as fruits and marine products, with reductions in spoilage and extension of marketing times; to establish the wholesomeness and safety for consumption for selected low-dose irradiated food items; and to develop prototype commercial food irradiation facilities. Also considered are nutritive, toxic, and carcinogenic aspects of irradiated foods, microbiological aspects, induced radioactivity, and other problems. (BBB)

**29946** COMPARISON OF THE EFFECT OF RADIATION OF VARIOUS PENETRATING POWERS ON THE DAMAGE TO CITRUS FRUIT PEEL. Kahan, R. S. (Soreq Nuclear Research Centre, Yavne, Israel); Monselise, S. P.; Riov, J.; van Kooy, J.; Chadwick, K. Radiat. Bot., 8: 415-23(Dec. 1968).

Parts of a single harvest of mature Shamouti oranges were irradiated with 25 to 240 Krad doses of ionizing radiation using $^{60}$Co γ-rays, 0.5 MV (surface) electrons or 1.5 MV electrons applied uniformly to the whole surface, and 1.5 MV (localized) electrons applied to either stem or stylar end or to the equatorial region of non-rotating fruits. Surface and deep electrons caused significantly more peel damage than γ rays. The extent of peel damage was similar after two and four weeks storage. Damage appeared only on that portion of the peel that had been irradiated; it was much more extensive at the stem end than at the stylar end. The dose-absorption profiles of the four radiation treatments within the peel layers differed markedly from each other, but their effects on ascorbic acid, reducing sugars, catalase and peroxidase activities were in general similar. The mature fruit of this experiment was less sensitive for these parameters than fruits picked earlier in the season. (auth) (UK)

**29947** STATUS OF RADIATION PRESERVATION OF MEAT AND POULTRY. Gruenewald, Th. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Fleischwirtschaft, 47: 463-6; 468(May 1967). (In German).

Thus far, sterilization of meat with high doses of gamma radiation has been submitted for approval only at the USA government and has been granted for bacon. Taste changes usually caused by radiation sterilization can only be avoided by special methods involving low temperatures or extremely high dose rates. Especially interested in pasteurization by radiation is the poultry industry. Low radiation doses causing no change of nutritional value can easily eliminate simonella in frozen meats. Application to the British government can be expected shortly to permit use of irradiated horse meat as animal food. (H.B.G.)

**29948** EFFECT OF MATING SEQUENCE ON EGG-HATCH FROM FEMALE AEDES AEGYPTI (L.) MATED WITH IRRADIATED AND NORMAL MALES. George, J. A. (Dept. of Agriculture, Ont.). Mosquito News, 27: No. 1, 82-6(Mar. 1967).

The egg hatch of female Aedes aegypti mated with normal males was not deduced by subsequent mating with irradiated males; conversely, the egg hatch from females mated with irradiated males was not increased by subsequent mating with normal males. Irradiated males appeared to mate as effectively as normal males. The timing and placement of the release of sterile males is important. (Public Health Eng. Abstr.)

**29949** PHYSICAL AND FUNCTIONAL PROPERTIES OF GAMMA-IRRADIATED LIQUID EGG WHITE. Ball, H. R. (Texas A and M Univ., College Station). Poultry Sci., 47: 1481-7(Sept. 1968).

Homogeneous, liquid egg white was treated with 0.000, 0.432, 0.576, 0.720, and 0.864 Mrad of γ radiation from a $^{60}$Co source. The irradiated samples were then frozen and held until used for measurements of physical and functional characteristics. Irradiation caused a reduction in viscosity, and a slight decrease in percent solids. Analysis of the electrophoretic patterns indicated a decrease in the relative concentration of proteins appearing in the ovomucin, conalbumin, and ovalbumin portions of the pattern and an increase in the relative concentration of proteins appearing in the globulins. Angel cakes made from the irradiated egg white required longer beating times in their preparation and had poorer texture and reduced volumes. Foams generated from irradiated egg white were less stable, as indicated by more extensive foam drainage. Functional performance as measured by beating time and cake volume improved during postirradiation frozen storage. (BBB)

**29950** RADIATION STERILIZATION OF MEDICAL DEVICES AND SUPPLIES. V. EFFECTS OF γ RADIATION ON THE PLASTIC PETRI DISH. Sato, Kenji; Oka, Mitsuru (Tokyo Metropolitan Isotope Research Center). Eisei Kagaku, 14: 312-15(Dec. 1968). (In Japanese).

The use of $^{60}$Co γ irradiation for sterilization of polystyrene petri dishes was investigated. It was found that the petri dishes which were heavily contaminated by the spores of B. subtilis and B. pumilus could be perfectly sterilized with γ irradiation at 2.5 Mrad. No significant coloring and crazing of the irradiated dishes or detrimental effect on their use in bacterial experiment was observed. From washing tests, it is supposed that the silicone on the surface of plastics is grafted with the plastics by means of irradiation at 2.5 Mrad. (NSA of Japan) (TSS)

**29951** THEORETICAL ASPECTS OF STERILIZATION OF GRAFTS FOR CLINICAL NEEDS BY MEANS OF IONIZING RADIATION. Ostrowski, Kazimierz; Moskalewski, Stanislaw; Komender, Janusz. Chir. Narzadow Ruchu Ortoped. Pol., 33: 311-24(1968). (In Polish).

After a discussion on the possibilities of sterilization using ionizing radiation, a method based on the exploiting of nuclear reactor when the neutron field was switched off is described. Containers with grafts were put into channels which were emptied for this time from fuel rods. Examination of survival of B. subtilis spores was used as tests of sterilization. Lyophilized bone grafts, sterilized by gamma radiation, underwent chemical and physical evaluation as well as assessment of changes in their antigenicity. During four years work 6,748 grafts were produced and used by plastic and orthopedic surgeons. (auth)

# METALS, CERAMICS, AND OTHER MATERIALS

## Metals and Alloys

*Refer also to abstracts 29091, 29107, and 31059.*

**29952** (GEMP-1010) AEC FUELS AND MATERIALS DEVELOPMENT PROGRAM PROGRESS REPORT NO. 78. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). Dec. 31, 1968. Contract AT(40-1)-2847. 315p. Dep. CFSTI.

The report is divided into ten sections. A separate abstract was prepared for each section. (J.C.W.)

*For abstracts of individual sections see: 30004–30011, 30099, and 30140.*

**29953** THE PHASE DIAGRAMS OF GROUP VIA METALS: CHROMIUM, MOLYBDENUM, AND TUNGSTEN. Kornilov, I. I.; Pryakhina, L. I.; Polyakova, R. S. pp 61-9 to Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

The main properties of the Group VIA metals (Cr, Mo, and W) are described. The results of a literature survey on binary systems involving these metals are tabulated. In the case of Cr the elements of the periodic system are classified according to their type of reaction with Cr, i.e., those that form continuous solid solutions, limited solid solutions, intermetallics, or do not react. These tables for Cr, Mo, and W make it possible to select alloying components for preparing new alloys. 45 ref. (Metals Abstr.)

**29954** COMPTES RENDU DES JOURNEE D'ETUDES SUR LES SOLIDES FINEMENT DIVISES, SACLAY, 27–28–29 SEPTEMBRE 1967. (Report of Studies on Finely Divided Solids, Saclay, 27–28–29 September 1967). Ehretsmann, J. (ed.). Paris, Documentation Francaise, 1968. 273p. (CONF-670980).

Thirty-six papers were presented at the conference. The preparation of five powders, the role of morphology and activity in ultrafine particles, and the chemical reactivity of five powders, were discussed. (R.C.K.)

**29955** MATERIALS SCIENCE IN ENGINEERING. Keyser, Carl A. Columbus, Ohio, Charles E. Merrill Publishing Company, 1968. 445p.

Metallic materials are described. Information is included on structure, elastic and plastic behavior, fatigue failure, high-temperature failure, and corrosion. Principles of alloying, diffusion, grain growth, and heat treatments are summarized. Classes of metals and alloys are discussed. Metal processing and its effects on metal properties are given. The mechanical behavior of nonmetallic materials is discussed. The properties of wood are examined. Electric properties and electronic behavior of metallic and nonmetallic materials are given. (J.C.W.)

**29956** METALS IN THE MODERN WORLD: A STUDY IN MATERIALS DEVELOPMENT. Slade, Edward. Doubleday Science Series. Garden City, N. Y., Doubleday and Company, Inc., 1968. 192p. $5.95.

A survey of the scope and nature of changes in metallurgy is presented. Information and discussions are included in chapters on the basic characteristics of metals, crystal structure, and defects in metals and alloys, metal extraction, fabrication and strengthening of metals, automation, and examination methods for metals. (J.R.D.)

**29957** PROCEEDINGS OF THE FIRST ANNUAL TECHNICAL MEETING OF THE INTERNATIONAL METALLOGRAPHIC SOCIETY, INC., NOVEMBER 11, 12, AND 13, 1968, DENVER, COLORADO. Johnson, K. A.; Bender, J. H. (eds.). Los Alamos, N. Mex., International Metallographic Society, Inc., 1969. 203p. (CONF-681107).

A total of 31 papers were presented at the meeting. A separate abstract was prepared for each of 18 papers. Papers for which no abstracts were prepared are concerned with nickel-iron alloys, Pearlite, Udimet 700, preparation and testing of Be, surface coatings, Pb metallography, shadowed replicas, nitride precipitates in Mo, Al–Zn alloys, and iron meteorites. (J.R.D.)

*For abstracts of individual papers see: 29958, 29972, 29994–29998, 30036, 30086–30093, 30102, and 30135.*

**29958** ELECTRON MICROAUTORADIOGRAPHY OF INDUCED RADIOACTIVITY IN SOLIDS. Asumaa, S. K. (Douglas Aircraft Co., Newport Beach, Calif.). Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 23-32(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

The techniques of introducing radioactivity in materials for selective microautoradiography of minor components and for quantitative evaluation of the radiograph information are discussed. The actual resolution is estimated as a function of the instrumental resolving power and the emission and penetration properties of the beta-particle. A proper design of experimental conditions in the recording phase as well as during specimen activation for optimum resolution and information are emphasized. (auth)

**29959** NESOVERSHENSTVA KRISTALLICHESKOGO STROENIYA. (Imperfection of Crystalline Structure). Svechnikov, V. N. (ed.). Respublikanskii Mezhvedomstvennyi Sbornik. Seriya Metallofizika. Kiev, Izdatel'stvo Naukova Dumka, 1968. 132p.

Nineteen articles are included on theoretical and experimental data on crystalline lattice studies using electron microscopy x ray, nuclear magnetic resonance, and other methods. The effects of induced crystal lattice dislocations and defects on the physical and mechanical properties of metals and alloys are discussed. Effects of dislocations on the shape of magnetic resonance lines, radiation effects on properties of nonequilibrium systems, neutron effects on monocrystals, effects of molybdenum on the kinetic parameters of deformed nickel recrystallization are discussed along with aspects related to temperature such as creep, ductility, and structural changes. (R.V.J.)

### Corrosion and Erosion

*Refer also to abstract 30880.*

**29960** (AECL-3285) THE MORPHOLOGY OF ZIRCONIA FILMS AND ITS RELATION TO THE OXIDATION KINETICS. Cox, B. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Feb. 1969. 29p. (CONF-690212-1). Dep. CFSTI. CAN $1.00.

From Symposium on Metal Oxidation, Chalk River, Ontario.

The morphology of oxide films formed on zirconium alloys, and the effects that changes in this with time may have on the oxidation kinetics are discussed. The structure and topography of the outer and inner interfaces of zirconia films formed thermally on zirconium alloys are complicated. While the topography of the oxide surface largely preserves the original metal surface topography, the behavior of second phase particles during surface preparation has a determining effect on this topography. The matrix $ZrO_2$ itself is microcrystalline and may be formed by crystallization of an amorphous layer continuously forming at the oxide-metal interface. The development of a columnar growth morphology in the thickening oxide apparently leads to a cellular structure at the oxide-metal interface superimposed on the finer scale roughness due to the crystallite size. The electronic current flows at the impurity particles that remain largely unoxidized and develop a thin multilayer barrier film composed of zirconia overlaid with haematite and magnetite (in Zircaloy-2 and Zr-Fe alloys). Variations in the relative thickness of these layers modify the electron current and with it the oxidation kinetics, in periods where these are controlled by electron flow. (auth)

**29961** (IS-T-299) LIQUID-METAL CORROSION EFFECTS OF IRON ADDITIONS ON URANIUM-CHROMIUM EUTECTIC IN YTTRIUM. Cash, Robert James (Ames Lab., Iowa). Feb. 1969. Contract W-7405-eng-82. 195p. Dep. CFSTI.

Thesis.

The results of corrosion tests with two proposed liquid-metal reactor fuels, uranium–5.0 wt % chromium eutectic and uranium–chromium–iron, contained in yttrium are presented. Based on results of differential thermal analyses and metallographic examinations, the existence of the ternary eutectic point in the uranium–chromium–iron system was tentatively identified at uranium–2.5 wt % chromium–2.5 wt % iron melting at 765°C. This is contrary to published data. A partial phase diagram was constructed for the uranium–chromium eutectic versus iron system using thermal analysis data. The dissolution-rate constant for yttrium in the uranium–chromium eutectic at 950°C was determined to be 0.0138 cm/min. The dissolution process was found to be solution controlled corresponding to the equation

$n_t(ppM) = 760\{1 - \exp[-0.0138(S/V)t]\}$ at 950°C. The solubility of yttrium in the uranium–chromium eutectic was found to be related by $\ln N_Y^{UCr} = 12.73 - 7,450/T°K$ from 900 to 1200°C. The results of the corrosion tests with uranium–chromium eutectic and the uranium–chromium–iron alloys showed that yttrium was not a satisfactory long-term container metal at 950°C and above. Additions of iron to the base uranium–chromium eutectic not only lowered the liquidus and solidus temperatures but also increased the amount of corrosion (solubility) of yttrium. While alloys with iron additions up to about 1.0 wt % were only slightly more corrosive, the larger additions (2.5 to 10 wt % iron) greatly increased the observed penetration. Dissolution corrosion attack occurred at a rate greater than that predicted theoretically for isothermal, static tests. The presence of silicon carbide impurity from abrasive paper used for polishing complicated the corrosion process by formation of a silicon–yttrium compound. Yttrium will successfully contain the pure uranium–chromium eutectic for periods in excess of 3000 hours under nominally static, isothermal conditions at 950°C. However, a dynamic loop system operating under a temperature differential would suffer mass transfer and fail in a shorter period of time either from penetration by the eutectic or plugging in the cold leg. (auth)

**29962** (GA–9299) AUTOCLAVE CORROSION TESTS OF WELDED AND BENT STEAM GENERATOR TUBES FOR PSC. Roberts, D. I.; Hildebrand, J. F.; Stetson, R. (Gulf General Atomic, Inc., San Diego, Calif.). Apr. 30, 1969. Contract AT(04-3)-633. 70p. Dep. CFSTI.

Results of 1000-hr autoclave corrosion tests that were performed in order to identify the effects of steam generator fabrication features on the stress corrosion behavior of Sanicro 31 Ni-Fe-Cr alloy are described. The tests were designed to show possible adverse effects of residual stresses from short radius bends and bimetallic welds. Both stress-relieved and non-stress-relieved specimens were tested. The tests were performed using environmental conditions which, from previous experiments relating to the Peach Bottom steam generators, were known to be very aggressive and capable of causing stress corrosion and pitting in austenitic steels. These environments were based on exposing the specimens to 1400-psi wet steam at 600°F with chloride-bearing water intermittently sprayed onto, and flashing off, the test specimen surfaces. In one set of tests the oxygen level in the steam was kept low (not detectable except at start of test), and the chloride was adjusted to a nominal value of 2 ppM in the effluent. In the other set of tests the chloride was maintained at the same level, but the oxygen content of the steam was raised to approximately 5 ppM. Results of these tests showed no evidence of stress corrosion cracking on either stress-relieved or non-stress-relieved specimens. It was concluded that stress-relief heat treatment of short radius bends and bimetallic welds was unnecessary from the standpoint of protection from chloride stress corrosion. In addition, it was concluded that weld root material resulting from Inconel 606 diluted with either Sanicro 31 or T22 plus Sanicro 31 is satisfactory from the chloride stress corrosion aspect. The test samples also exhibited some pitting and galvanic corrosion in the high-oxygen test environment, but this condition was not considered significant since the PSC steam generators will operate using a secondary coolant of extremely low conductivity and low-oxygen content. (auth)

**29963** (LMEC–69-11) CORROSION OF TYPE 18-18-2 STAINLESS STEEL IN 1200°F STATIC SODIUM. Lee, W. T. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). May 15, 1969. Contract AT(04-3)-700. 35p. Dep. CFSTI.

Coupons of Type 18-18-2 stainless steel were immersed in 1200°F static sodium for periods up to 5060 hr. In addition, 12 Type 304 stainless steel tabs were simultaneously exposed for comparison. The average oxygen impurity in the sodium was about 30 ppM. The results of these preliminary tests show that Type 18-18-2 stainless steel is sufficiently corrosion-resistant in 1200°F sodium to warrant more thorough evaluation. (auth)

**29964** (MSAR–69-91) THE EFFECT OF HIGH-TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. TOPICAL REPORT NO. 13. OXIDATION OF STAINLESS STEEL IN OXYGEN-CONTAMINATED HIGH-TEMPERATURE SODIUM. Hiltz, R. H. (MSA Research Corp., Evans City, Pa.). May 1969. Contract AT(11-1)-765. 28p. (XAC–720264). Dep. CFSTI.

The exposure of the 300-series stainless steels to sodium at 1200°F contaminated with oxygen resulted in the formation of a gray surface scale. The oxygen content is at least in excess of 20 ppM. The scale forms as a function of time and oxygen concentration. It begins as a surface layer but penetrates along grain boundaries into the base metal. The surface scale is easily spalled and is difficult to retain for out-of-loop analyses. For this reason, it is difficult to obtain meaningful numbers to define a corrosion rate as such. The scale is interspersed with ferritic iron islands of both microscopic and submicroscopic size. A series of analyses involving x-ray, electron micrography and electron microprobe have established that the scale is sodium chromite, $Na_2Cr_2O_4$. The corrosion process is selective for chromium and the iron and nickel concentration in the scale varies between 0.1 and 0.3%. There is little evidence of an embrittling effect beneath the surface of the scale. Limited tests run in oxygen-contaminated high-velocity sodium show that whole grains can be eroded from the surface due to the embrittling effect of the oxide along the grain boundaries. If the exposure temperature is raised to 1400°F, considerable changes take place in the oxidation process. The scale has a green color. It forms as a thin surface layer with the internal penetration considerably less than that which would occur at an equivalent time and oxygen level at 1200°F. Analyses conducted with x-ray, electron microscopy and electron microprobe have not been able to identify the scale. A distinctive x-ray pattern is available, but it does not coincide with any known compound. The scale has a lower chromium content than sodium chromite, —36.0 vs 46.5 wt %. Sodium is present only in a few percent and nickel is present as less than 1%. Iron is present in a higher concentration than the gray scale but is still only 1.5%. There are indications that the green scale is made up of two components, —a major and a minor phase. Both undergo transformations upon exposure to 1200°F sodium, with the major phase converting to sodium chromite. (auth)

**29965** (N–69-20195) A 9Cr–1Mo STEEL AS A MERCURY CONTAINMENT MATERIAL FOR THE SNAP-8 BOILER. Farwell, B. E.; Yee, D.; Nakazato, S. (Aerojet-General Corp., Azusa, Calif.). Jan. 1968. Contract NAS5-417. 91p. (NASA-CR–72503; AEROJET–3661). CFSTI.

Various investigations were made to evaluate 9Cr–1Mo steel as a mercury containment material for use in the SNAP-8 boiler. Analysis and experimental data indicate that mercury corrosion of 9Cr–1Mo can be described as a mass transfer process of soluble constituents of the steel into mercury. Mercury corrosion rate is maximum under wetted condition and only such data should be used in evaluating the suitability of the 9Cr–1Mo steel. (auth) (STAR)

**29966** (ORNL-TM–1361) COMPATIBILITY OF STRUCTURAL MATERIALS WITH BOILING POTASSIUM. DeVan, J. H. (Oak Ridge National Lab., Tenn.). Apr. 1966. Contract W-7405-eng-26. 72p. Dep. CFSTI.

The suitability of austenitic stainless steels, nickel-base alloys, cobalt-base alloys, and refractory metals for use as structural materials in boiling-potassium systems is examined with particular attention to corrosion and mass transfer. Experience from the ANP, MCR, SNAP-8, SNAP-50, and MPRE programs is summarized and related to the corrosion requirements of a boiling-potassium Rankine-cycle system. Results indicate that in a recirculating boiler with an efficient vapor separator, mass transfer effects are counter to those in an all-liquid system. Solution is restricted to the cooler zones and deposition to the hottest zone (i.e., the boiler) as potassium is distilled off and dissolved material is left behind. This hypothesis is evaluated against data for boiling-potassium systems, and the results observed are consistent with the hypothesis. Mass transfer rates are notably lower than in all-liquid systems, and in the absence of contamination effects recirculating boilers have shown negligible corrosion. A review of strength properties, corrosion and mass transfer problems, fabricability, availability, and costs reveals that type 304 is the best suited of the stainless steels for use in the MPRE and should be satisfactory for a design life of 10,000 hr at 1550°F. The relative merits of nickel-base, cobalt-base, and refractory-metal alloys are compared for operation at temperatures above 1550°F. Refractory metals appear to permit a substantially higher operating temperature and actually pose less in the way of materials development problems than a nickel- or cobalt-base alloy. (auth)

**29967** (WCAP–7099) ABSORPTION OF CORROSION–HYDROGEN BY A302B STEEL AT 70° TO 500°F. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Dec. 1, 1967. 37p.

Specimens of A302B steel were exposed to boric acid solution, both aerated and deaerated, at temperatures varying from 74 to 500°F. The corrosion of the A302B steel was determined for the exposures along with the hydrogen pickup in the steel from this corrosion. The program included exposure of isolated coupons of the A302B steel as well as coupons coupled to 304 stainless steel. The corrosion results indicated that A302B steel would corrode at

a maximum of about 2450 mg/dm²-month in 140°F aerated boric acid solution while in deaerated boric acid solution the corrosion rate was about 10 to 30 mg/dm²-month for all low temperature exposures. The results from the hydrogen analyses indicated that the maximum hydrogen present in the A302B steel from corrosion was less than 2 ppM and did not increase with total corrosion or time. (auth)

**29968** (WERL-3203-10) HYDROGEN REACTIONS WITH ALLOYS OF ZIRCONIUM AND THE METALS VANADIUM, CHROMIUM, IRON, COBALT, NICKEL, COPPER, MOLYBDENUM, NIOBIUM, AND TIN. Final Report, June 1, 1963–June 1, 1967. Gulbransen, E. A.; Andrew, K. F.; Jansson, S. A.; Pebler, A. R. (Westinghouse Research Labs., Pittsburgh, Pa.). Contract AT-(30-1)-3203. 188p. Dep. CFSTI.

Studies were made of the reaction of liquid water, water vapor and hydrogen with a wide variety of well characterized zirconium alloys of interest in nuclear reactors. Included are (1) hydrogen absorption studies of a number of dilute alloys, a series of intermetallic alloys and of Zircaloy-4, (2) kinetic studies of the reaction of water vapor and liquid water with 22 alloys, and (3) a theoretical analysis of the mechanisms of oxidation and hydrogen absorption and of the influence of nickel and other alloying elements on the reactions. (auth)

**29969** THE EFFECT OF CHANGING THE CORROSIVE MEDIUM ON THE OXIDATION OF Zr–1 PERCENT Nb ALLOY IN PRESSURIZED STEAM AND AIR. El-Shanshoury, I. A.; Rudenko, V. A.; El-Dahshan, M. E.; Hammad, F. H. (Atomic Energy Establishment, Cairo). Corros. Sci., 9: 315-22(May 1969).

The effect of changing the corrosive medium from pressurized steam to air and vice versa on the oxidation of Zr–1% Nb alloy was studied at 450 and 500°C. The corrosion rate in steam is higher than that in air. Experiments conducted in air on specimens having different thicknesses of oxides formed in steam showed the presence of an incubation period during which no observable change in weight was detected. The incubation period was linearly dependent on the square thickness of the oxide film formed in steam. It also depended on temperature, decreasing with an increase in temperature. Similarity between the slope of this relation and the diffusion coefficient of oxygen in zirconium dioxide was found, from which an activation energy of 38,000 cal/mol. was obtained. No incubation periods were observed for specimens oxidized in air followed by corrosion in steam. The results obtained suggest that the nature of the lattice defects developed in oxides formed in steam and air is different. Defects formed in steam do not take part in the growth of the oxide film and are responsible for the retarding action of further oxidation in air while those developed in air participate and respond to further oxidation in steam. (auth) (UK)

**29970** SOME OBSERVATIONS ON THE OXIDATION OF Zr–Cu–Mo AND Zr–Cu–W ALLOYS IN STEAM AT 400°C, 1500psi. Moon, J. R.; Evans, E. W. (Imperial Metal Industries (Kynoch) Ltd., Birmingham, Eng.). Corros. Sci., 9: 323-7(May 1969).

The influence of the microstructures of Zr–Cu–Mo and Zr–Cu–W alloys on their resistance to oxidation in steam at 400°C, 1500 psi was investigated. The optimum corrosion resistance was found to correlate with a quenching and ageing treatment which yielded microstructures containing small, evenly dispersed particles of $Zr_2Cu$ in a matrix of α-Zr. The effects of ageing on the oxidation resistance of the quenched alloys are discussed in relation to the microstructural changes brought about both by the ageing itself and by the test conditions. (auth) (UK)

**29971** ZASHCHITNYE POKRYTIYA NA METALLAKH. VYPUSK 2. Sbornik Soderzhit Doklady, Prochigannye na Shestom Zasedanin Seminara po Diffuzionnomu Nasyshcheniyu i Pokrytiyam, Sostoyavshemsya v Oktyabre 1966 g. v Odesse. (Protective Coatings on Metals. No. 2. Reports of the Sixth Seminar on Diffusion Saturation and Protective Coating, Odessa, October 1966). Samsonov, G. V. (ed.). Kiev, Naukova Dumka, 1968. 296p.

Forty four articles are included on diffusion saturation and new methods for protective coating. Chemical thermodynamics of complex precipitation of elements on the metals, protective coating from gaseous phase on solids, properties of materials with protective coating, and analysis of thermal and velocity jets on the material are discussed. High-temperature tests of coated metals, vacuum diffusion, thermodiffusion of Mo by B and W–Si are analyzed as well as borating and carbonization of spherical powders of Nb, Mo, and W. (R.V.J.)

**29972** TITANIUM CORROSION CRACKING MORPHOLOGY. Krystkowiak, Stanley; Cowgill, Dale S. (Lockheed-California Co., Burbank). Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 141-5(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

The mode of stress corrosion cracking in 8Al-1V-1Mo titanium alloy was observed metallographically. A notched and fatigue pre-cracked specimen was used in three-point loading. The specimen was loaded and exposed to 3% NaCl solution to initiate cracking. It was then unloaded after stress cracking was initiated. Micrographs were then taken of the entire surface of the crack at regular intervals of 0.004 to 0.010 inch through the width of the specimen. This was accomplished using a sequence of lapping, polishing, and micrography. Thus, a three dimensional model of the corrosion crack was generated. Additional micrographs were obtained at 3000× to study the crack propagation through the titanium structure. (auth)

**29973** OXIDATION OF ZIRCONIUM–COPPER ALLOYS IN CARBON DIOXIDE AT HIGH TEMPERATURES. Darras, Raymond; Loriers, Henri; Baque, Pierre (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. C, 268: 1317-20(Apr. 14, 1969). (In French).

In carbon dioxide gas between 600 and 700°C, zirconium–copper alloys containing between 1 and 4% copper by weight are not damaged as is unalloyed zirconium. Indeed, layers of zirconium containing copper formed on these alloys are definitely less sensitive to cracking than pure zirconium. (tr-auth)

**29974** CINEMATOGRAPHIC STUDY OF THE OXIDATION OF ZIRCONIUM UNDER REDUCED OXYGEN PRESSURE. Dechamps, Michel; Debuigne, Jean; Lehr, Pierre (CNRS, Val-de-Marne, France). Compt. Rend., Ser. C, 268: 1499-1501(Apr. 28, 1969). (In French).

The oxidation of zirconium under a stream of oxygen at fixed pressure was followed by means of a microscope with a heated stage. The processes of growth of the surface film of zirconium oxide were followed as well as the eventual dissolution of the oxide formed in the course of maintaining it under vacuum. This study shows an important anisotropy in the oxidation of zirconium and of the diffusion of oxygen in the metallic lattice. (tr-auth)

## *Preparation and Fabrication*

*Refer also to abstracts 29037, 29044, 30030, 30031, 30120, and 30137.*

**29975** (BM-RI-7151) MODEL FOR MOLTEN POOLS IN ARC MELTING. Wood, Floyd W. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). July 1968. 33p.

A mathematical analysis based on a separation of variables, using conventional differential equation methods, is used to examine the in-process temperature distribution in a hypothetical ingot as a boundary value problem. For a cylindrical ingot, the temperature varies as a Bessel function of an argument proportional to the radius and as an exponential function of longitudinal position. Trial calculations using the problem solution seem to verify the general correctness of the result as compared with experience. The role and nature of solution parameters are also clarified, though not entirely resolved. It is revealed that the barrier to heat flow at the ingot-crucible surface has a prominent influence. Utility of the model embodied in the problem solution is readily demonstrated by considering a variety of contemporary questions about arc melting. (J.C.W.)

**29976** (BM-RI-7265) PREPARATION OF THORIUM METAL BY VACUUM DISTILLATION OF ELECTRODEPOSITED THORIUM–CHROMIUM AND THORIUM–MANGANESE ALLOYS. Murphy, James E.; Morrice, E.; Wong, M. M. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). June 1969. 9p. Bureau of Mines Free.

The high-purity thorium metal was prepared from electrolytically produced thorium alloys. The thorium-chromium and thorium-manganese alloys were separated into the component elements by vacuum distillation. Chromium and manganese impurities remaining in the thorium metal after distillation at 1850°C were <0.005 wt %. Removal of volatile impurities such as aluminum, calcium, magnesium, and lead was also accomplished. (auth)

**29977** (CEND-3742-352) VANADIUM PURIFICATION. Ninth Quarterly Progress Report, October 1, 1968–March 31, 1969. La Vake, J. C.; Christopher, S. S.; Stewart, J. R. (Com-

bustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). Apr. 1969. Contract AT(30-1)-3742. 16p. Dep. CFSTI.

Stress-rupture testing was continued on the high purity V–15Cr–5Ti sheet to obtain data on time-to rupture and minimum-creep-rate properties. Five hundred-hour stress-rupture tests have shown contamination; however, modifications to the creep furnace, are expected to eliminate this. Recrystallized sheet has been electron beam and TIG welded. The TIG welds showed low ductility due to precipitate agglomeration. Heat treatments are being performed in an attempt to increase ductility. Electron beam welds, with their faster cooling rates, showed good ductility. (auth)

**29978** (CONF-680810–, pp 137-61) ALUMINUM. Chapman, J. R. (Aluminum Co. of America, Pittsburgh, Pa.).

The technology and economics of producing primary aluminum are presented briefly. Operations from mining through fabrication to sheet and plate are described. Investment and operating cost factors are included, chiefly as tables and graphs. Flow charts and photographs illustrate the principal features of the processes involved. (auth)

**29979** (CONF-680810–, pp 163-80) MAGNESIUM. Fougner, Sven (Magnalith Corp., New York).

Two currently employed electrolytic reduction processes, both based on seawater magnesia, are reviewed and a novel technology is outlined for deriving magnesium from brine magnesium chloride and thereby improving process economics with coproduced chlorine. Typical uses of the metal are described in text and illustrations, and the competitive relation, magnesium vs. aluminum, is illustrated by examples. (auth)

**29980** (CONF-680810–, pp 181-96) IRON AND STEEL WITH HYDROGEN. Squires, Arthur M. (City Coll., New York).

Ironmaking processes suitable for providing a reduced-iron product to electric steelmaking furnaces are considered. Suitable processes employing reducing gases produced from natural gas include those that reduce a lump ore in a static or gravitating bed at temperatures above about 1600°F and the H-Iron process, in which finely divided ore is reduced by hydrogen in a fluidized bed operating at about 900°F and 500 psi. Only the latter process is suitable for using hydrogen produced by an advanced technique for electrolyzing water. When such a technique and breeder power reactors become available, a steel industry can be sited economically without regard to the availability of fossil fuels. (auth)

**29981** (CONF-680810–, pp 197-201) ELECTROWINNING OF METALS. Rosenbaum, Joe B. (Bureau of Mines, Salt Lake City, Utah, Salt Lake City Metallurgy Research Center).

Power use in electrowinning some 3 million tons of aluminum in 1966 was about 54 billion kW-hr. Production of steel in electric furnaces used 30 billion kW-hr, ferroalloys used about 14 billion, and elemental phosphorus used about 7 billion. The relation between cost of energy for electrowinning and the selling price of selected metals is presented to illustrate the incremental benefit of cheaper power. The outlook for uses of electricity in electrometallurgy is discussed. (auth)

**29982** (GAMD–9145) CENTRAL REFABRICATION PLANT FOR HTGR FUELS. Stelling, H. E. (Gulf General Atomic, Inc., San Diego, Calif.). Mar. 15, 1969. Contract AT(04-3)-167. 70p. CFSTI.

Preliminary designs, capital costs, and operating costs have been developed for an HTGR fuel element refabrication facility utilizing bred $^{233}U$ produced from the irradiation of thorium. The plant design presumes remote operation and direct maintenance for those parts of the facility handling $^{233}U$. The sol-gel process is used to convert uranyl nitrate solutions received from an off-site reprocessing plant into $^{233}U$ oxide fuel particles. The fuel particles are then carbon coated, and combined with coated thorium and coated $^{235}U$ particles and graphite fuel blocks to form HTGR fuel elements. Segregated loading of fuel elements is employed to keep the portion of the facility requiring shielding as small as possible and to minimize fuel element shipping costs. This segregation is satisfactory from a core physics standpoint. The estimated annual operating cost and fixed charge for the refabrication facility is 8.1 million dollars. The refabrication cost is $51.6/kg of heavy metals fabricated not including the cost of purchased fuel element components (coated Th and $^{235}U$ particles and the graphite blocks) and not including the cost of the uranium and thorium. The total cost for the average fuel element refabrication is shown based on these refabrication and assembly costs and on varying prices for purchased fuel element components. For fuel element component costs of $500/graphite fuel block, $200/kg of $^{235}U$ particles, and $50/kg of thorium particles, the cost of an average fuel element is about $148/kg of thorium plus uranium, or about $1630/fuel element. Average fuel elements produced in the plant include some fuel elements that do not contain $^{233}U$. (auth)

**29983** (JEN–200-DME/I-20) WELDING OF ZIRCALOY-2. Rodriguez-Solano, R.; Jimenez Moreno, J. M. (Junta de Energia Nuclear, Madrid (Spain). Division de Metallurgia). 1968. 24p. (In Spanish). Dep.

A review of Zircaloy-2 TIG welding is presented. Equipment and procedures used in tests of this method are included. Results of TIG welding tests using Ar with 7 and 96 ppM impurities are discussed along with tests using He. (J.R.D.)

**29984** (LA–4099) POWDER EXTRUSION OF TUNGSTEN TUBING. Erickson, W. C.; Javorsky, C. A. (Los Alamos Scientific Lab., N. Mex.). Dec. 1968. Contract W-7405-eng-36. 19p. Dep. CFSTI.

A development program for the fabrication of refractory metal tubing by powder extrusion has been underway for several years. Current development work shows that microcracking can be eliminated by using a minimum amount of binder and a slow low-temperature cure. Final theoretical densities of 97% were obtained on sintered tubing ranging in wall thickness from 0.025 to 0.110 in. (auth)

**29985** (SC-R–69-1233) DEVELOPMENT OF SHEAR SPINNING TECHNOLOGY FOR BERYLLIUM. Sernka, Richard P. (Philco-Ford Corp., Newport Beach, Calif. Aeronutronic Div.); Ledman, John L. (Sandia Labs., Albuquerque, N. Mex.). Apr. 1969. 34p. (CONF-690415–1). Dep. CFSTI.

From 10th Structures, Structural Dynamics and Material Conference, New Orleans, La.

The extent to which beryllium products can be hot formed into conical shapes by sine law shear spinning was determined. With successful process development, economies in time and material are realized; furthermore, with process optimization, enhancement of mechanical properties through thermomechanical processing may be realized. Both wrought ingot plate and vacuum hot pressed block material were included in the study. The materials are characterized with respect to source, production practice, chemistry, and microstructure. Elevated temperature bend, tensile, and hardness tests were used to select optimum forming conditions. In the process development, required reductions, rates of deformation, lubrication, effects of tool geometries, and in-process heat treatments were studied. The mechanical properties and textures produced in formed cones were determined. Particular care is used to control process variables, with workpiece temperature control most critical. Results of the study indicate that Be can be shear formed under proper process controls. Particular care must be exercised in selection of input material. (auth)

**29986** (SCL-DC–68-50) PREPARATION OF URANIUM FOR ELECTROPLATING WITH NICKEL. Dini, J. W.; Coronado, P. R. (Sandia Labs., Livermore, Calif.). Oct. 1968. Contract AT-(29-1)-789. 31p. (CONF-690505–1). Dep. CFSTI.

From Metal Finishing Conference, London, England.

A process was developed for reliably protecting unalloyed depleted uranium with an adherent, corrosion-resistant electroplated deposit. The key to the process was treatment of the uranium with a metal chloride/nitric acid solution before plating. Solutions containing stannous or nickel chloride yielded results superior to those of solutions containing other metal chlorides. For production purposes, however, the nickel chloride solution—because it could be operated at a lower temperature, removed less metal, and was more stable—was preferable to the stannous chloride solution. Plated parts that had been pretreated in any of the metal chloride solutions investigated were capable of withstanding exposure to a water-saturated atmosphere at 200°F for at least ninety hours without showing signs of deterioration. Plated parts pretreated in the stannous chloride solution showed no signs of deterioration after five years of outdoor exposure at Livermore, Calif. A significant additional discovery was that the use of an alkaline immersion cleaning cycle before and after pretreatment noticeably improved the corrosion resistance of plated parts, not only when the metal chloride/nitric acid solution was used, but especially when other, inferior pretreating solutions were used. (auth)

**29987** (USBM-RC–1355) QUARTERLY METALLURGICAL PROGRESS REPORT NUMBER 40, JULY 1–SEPTEMBER 30, 1968. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Contract AT(11-1)-599. 30p. Dep. CFSTI.

Investigations of the binary systems V–O, V–N, and V–C were continued. A process investigated to prepare $Na_4FeO_3$ was not successful. Experiments to prepare $V_2N$ led to the establishment of a synthesis procedure. Progress on the purification of tungsten, vanadium, and zirconium is reported. The refining of vanadium scrap was concluded. Testing of all scrap samples was conducted and the results are tabulated. (J.C.W.)

**29988** RESEARCH LABORATORIES OF THE S.I.C.N. AT VEUREY (ISERE). Fuhrmann, Robert. Ind. At., 13: No. 1-2, 35-40(1969). (In French).

Aspects of fuel element fabrication as performed at the Veurey research laboratories are analyzed to determine the efficiency of the procedure and the quality of the product. Discussions are included on continuous casting, transformation of U–Mo alloys, design and performance of the Chinon-2 element centering tool, and welding of steels by electron bombardment. The procedures were found satisfactory. (J.S.R.)

**29989** CALCIUM ALLOYS: THEIR PREPARATION, PHASE DIAGRAMS, AND THE EFFECTS OF ALLOYING ADDITIONS ON MECHANICAL PROPERTIES. Terekhova, V. F.; Stroganova, V. F.; Savitskii, E. M. pp 119-24 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

The method of preparation of alloys of Ca with elements of the Groups I through V of the Periodic Table and a theoretical generalization of the nature of the reaction are given with certain suppositions on the phase diagrams which have not so far been studied. The effect of alloying additions of Cu, Mg, Zn, Al, Y, Pb, and Bi on mechanical properties of cast Ca is examined. 22 ref. (Metals Abstr.)

**29990** METHOD OF ELECTRODEPOSITION OF ZINC–CADMIUM ALLOY. Kochman, E. D.; Kravtsova, R. L.; Golovanova, S. K. Russian Patent 219,355. (In Russian).

A method is described for electrodeposition of zinc-cadmium alloy in a solution of zinc and cadmium sulfates with an addition of ethylendiamine. To reduce the toxicity of the electrolyte and to increase its stability, potassium pyrophosphate is added. The chemical composition of the electrolyte is 6 to 10 g/l cadmium sulfate, 25 to 35 g/l zinc sulfate, 140 to 200 g/l pyrophosphate, 15 to 40 ml/l ethylendiamine, and 1 g/l joiner's glue. The process is carried out at 40 to 60°C with a 0.5 to 5 A/dm$^2$ current density and a pH of 11 to 12. (JPRS)

**29991** ELECTRODEPOSITION OF INDIUM IN A COMPLEX POLYETHYLENEPOLYAMINE ELECTROLYTE. Kokorev, N. R.; Ryabchenkov, A. V.; Rykova, A. V. Zashch. Metal., 4: 116-18 (1968). (In Russian).

The possibility of obtaining a stable aqueous solution of complexes of indium with the amines entering in the composition of polyethylenepolyamine was verified. The conditions for the formation of these complexes were investigated. The electrolytes were prepared from distilled water and chemically pure salt of indium sulfate $In_2(SO_4)_3 \cdot 9H_2O$, using platinum anodes. A stable aqueous solution of complexes of indium with polyethylenepolyamine is obtained in the presence of a mutual ratio of 1:8 between In (metal) and polyethylenepolyamine. Addition of ammonium sulfate to the solution enhances its stability and increases the throwing power of the electrolyte. Current density markedly affects the cathodic current yield and the throwing power; thus when current density is increased from 0.7 to 4.5 A/dm$^2$ the current yield decreases from 60 to 35% and throwing power, from +60 to +40%. In an electrolyte with pH = 7.5 to 10.5 and a concentration of indium sulfate corresponding to 10 to 15 g of indium metal per liter; polyetheylenepolyamine, 80 to 120 g/liter; ammonium sulfate, 80 to 100 g/liter; it is possible to precipitate at room temperature a fine-crystalline light residue with satisfactory distribution over the cathode surface at a current density of 0.5 to 5 A/dm$^2$. The adhesion between the coating and the base is satisfactory, as verified by bending tests. The feasibility of obtaining stable aqueous solutions of complexes of indium with the amines of polyethylenepolyamine and of electrodepositing from them quality indium coatings, was established. (JPRS)

**29992** STRENGTHENING OF NIOBIUM–ZIRCONIUM ALLOYS BY INTERNAL OXIDATION. Rowcliffe, D. J.; Bonesteel, R. M.; Tietz, T. E. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Met. Soc. Conf., 47: 741-50(1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

The yield and ultimate tensile strengths of Nb–1Zr and Nb–1W–1Zr alloys at room temperature have been doubled by internal oxidation of 0.040-in.-thick sheet at 800°C. Creep rupture tests at 800 and 1200°C indicate the creep resistance of the ternary alloy is greatly increased as a result of this treatment. Transmission electron microscopy has revealed that coherent zones, less than 100 Å in size, were formed during internal oxidation of recrystallized Nb–1W–1Zr at 800°C while a coarser dispersion was formed at 900°C. The zones are thought to be composed of zirconium and oxygen atoms. After exposure at 1200°C the zones formed at 800°C were not seen; instead, massive precipitates of monoclinic zirconium oxide were formed. Straining prior to internal oxidation at 800°C produces discrete precipitates on the dislocations rather than random nucleation of zones. (auth)

**29993** FORMATION OF CRACKS DURING WELDING OF DILUTE URANIUM ALLOYS. Azarenko, A. V.; Stukalov, A. I. At. Energ. (USSR), 25: 532-4(Dec. 1968). (In Russian).

Uranium alloys with 1 at. % Si, 0.75 at. % Fe, 1.5 at. % Al used as fuel rods were studied to determine the reason for cracks forming during welding. Analysis of uranium rods with up to 1 at. % Si welded under 20 to 30 kg/mm$^2$ pressure, welding current 10,000 A, 2 to 3 V, and 0.2 sec time of current passage showed $\beta$ phase fixed in the region of the joint along the cross section of the seam. The supercooled region of the $\beta$ phase had a lenticular type structure. During annealing the $\beta$ phase disintegrates and a crack is formed at the joint zone. The diagram of the isothermal $\beta \rightarrow \alpha$ conversion indicated that at 600 to 400°C the conversion takes ~20 sec. The comparably short disintegration time permitted selection of such a type of cooling which resulted in complete $\beta$-phase disintegration in the presence of external pressure which eliminated cracks. Experiments confirmed this postulation. (R.V.J.)

**29994** METALLOGRAPHIC PREPARATION OF HOLMIUM. Dobbins, Anna G. (Union Carbide Corp., Oak Ridge, Tenn.). Contract W-7405-eng-26. Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 93-6(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

Cathodic etching of holmium metal under an argon atmosphere produced a structure that was essentially identical in major details to that produced by careful hand polishing or chemical polishing. In addition, the surface produced was relatively reaction free. (auth)

**29995** ELECTROLYTIC POLISHER-ETCHER FOR STANDARD METALLOGRAPHS. Arrowsmith, H. W.; Rencken, D. G. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 17-22(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

A low cost polishing etching cell which permits continuous observation of the sample surface during polishing and etching was developed for use with most inverted stage microscopes. Observation of the sample permits accurate control of the current density, electrolyte flow rate, and electrolyte composition for optimum polishing and etching results. Observation also allows the etching process to be viewed at the same magnification as the photomicrographs. This allows the etching process to be stopped when the sample has been etched sufficiently to show the desired features. The polishing etching cell has been designed to operate at temperatures up to 150°C with any electrolyte. Procedures are enumerated for electrolytic polishing and electrolytic etching unalloyed plutonium, stabilized delta plutonium, copper, stainless steel, titanium, and tantalum. Photomicrographs are included to show that satisfactory microstructures can be obtained quickly using the electrolytic polishing-etching cell. (auth)

**29996** SIMPLIFIED METALLOGRAPHIC TECHNIQUE FOR BERYLLIUM. Calabra, Arthur E.; Marts, Don L.; Capes, James F. (Dow Chemical Co., Golden, Colo.). Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 71-8(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

Two economical methods for the electrolytic polishing of vacuum-cast ingot sheet and powder pressed beryllium are described. These are simplified methods to enable rapid determination of the grain structure characteristics during the fabrication of the beryllium. A mechanical polishing technique for powder pressed beryllium is also described. The latter method is a precise preparation technique for the retention of inclusions, resolution of the grain structure, and preparation of high quality photomicrographs. (G.M.C.)

**29997** METALLOGRAPHIC TECHNIQUES FOR VACUUM-CAST ROLLED INGOT BERYLLIUM SHEET. Calabra, Arthur E.; Jackson, Ross J. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 63-70(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

Two techniques developed for the metallographic preparation of vacuum-cast ingot beryllium sheet are described. Both methods yield metallographically prepared surfaces considered to be of the highest quality. The first method retains inclusions and requires polarized illumination for structural delineation. The second method is an electrolytic swab-etch technique which yields bright-field delineation of the microstructure; however, inclusions are not retained. Emphasis in the report is mainly on illustrating the effects that improper preparation can have on the resulting microstructure. (auth)

**29998** A TECHNIQUE FOR THE METALLOGRAPHIC PREPARATION OF METALLIC SODIUM. Bender, J. H. (Los Alamos Scientific Lab., N. Mex.). Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 33-6(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

A technique for the metallographic preparation of metallic sodium is described. This includes mounting the sodium in a low-melting alloy, deep freezing the specimen and mount in liquid nitrogen, grinding, polishing and experimental etching procedures, and the photomicrography of the specimen utilizing a portable helium chamber with an optical glass viewport. (auth)

**29999** ROLLING OF MOLYBDENUM IN VACUUM AND IN AN ARGON ATMOSPHERE. Dolzhenkov, F. E.; Sigalov, Yu. M.; Mal'tsev, M. V.; Bat, Yu. I.; Volchek, F. R. Sb. Tr., Ukr. Nauch.-Issled. Inst. Metal., No. 12, 163-70(1966-67). (In Russian).

The process of rolling commercially pure molybdenum in the temperature range from 600 to 1300°C with a reduction in area of 10 to 40% was investigated. By rolling in a vacuum of $\sim 10^{-5}$ mm Hg and in Ar, the specific pressures, torsional moments, forward slip spread, and friction are higher than those during rolling in air over any temperature range and reduction in area. (JPRS)

**30000** ALLOY FORMATION BETWEEN LOW AND VERY HIGH MELTING METALS BY REDUCTION OF VOLATILE METAL HALIDES AND DETERMINATION OF THE STRUCTURE OF MOLYBDENUM-ZINC ALLOYS OBTAINED BY THIS METHOD. Heumann, Theodor; Schleicher, Hans-Walter; Venker, Hans (Univ., Muenster, Ger. EURATOM, Ispra, Italy). Z. Metallk., 60: 438-41(May 1969). (In German).

A process is described for the preparation of alloys of metals with widely different melting points. Volatile halides of the high-melting point component are passed through the liquid low-melting point metal where they are reduced. The liberated metal atoms react with the melt and equilibrium conditions are obtained because kinetic effects, such as too small diffusion rates are eliminated. Mo-Zn alloys were prepared by this method and the corresponding phase diagram was determined by microscopic, thermoanalytic and x-ray examination. (auth)

## *Properties Evaluations*

*Refer also to abstracts 29015, 29016, 29989, 30067, 30085, 30097, 30142, 30146, 30153, 30156–30158, 30171, and 31236.*

**30001** (AGN-8194(Vol.1)) THERMODYNAMIC AND TRANSPORT PROPERTIES OF POTASSIUM THERMAL CONDUCTIVITY OF THE VAPOR. Alkali Metals Evaluation Program. Achener, P. Y.; Jouthas, J. T. (Aerojet-General Corp., San Ramon, Calif. Nuclear Div.). Nov. 1968. Contract AT(04-3)-368. 70p. Dep. CFSTI.

The thermal conductivity of potassium vapor at 892 to 1056°K at pressures from 0.173 to 0.805 atm with superheat ranging from 20 to 65°K is reported. The heat transfer to laminar flow method was used to generate the experimental data. The tests were performed with a specially designed apparatus, fabricated from Nb-1% Zr alloy, which consisted of two boilers, a superheater, a test section (including a thin circular tube in which the measurements were performed), a condenser and a flow measuring device. (auth)

**30002** (AGN-8296) ALKALI METALS EVALUATION PROGRAM. Quarterly Progress Report, April 1–June 30, 1968. Achener, P. Y. (Aerojet-General Corp., San Ramon, Calif. Nuclear Div.). Sept. 1968. Contract AT(04-3)-368. 18p. Dep. CFSTI.

Efforts devoted to determination of thermodynamic and transport properties of rubidium and cesium have continued. Experimental data on the vapor thermal conductivity for rubidium are tabulated. The Prandtl numbers for cesium and rubidium vapors are presented graphically. Experiments to determine the thermal conductivity of K vapor were performed at 1000 to 1500°F. The liquid viscosity and liquid specific heat of lithium and sodium, and the vapor pressure of lithium were determined. Research on the surface tension, contact angle, and liquid thermal conductivity of Li and Na has been initiated. (J.C.W.)

**30003** (AGN-8305) ALKALI METALS EVALUATION PROGRAM. Quarterly Progress Report, July 1–September 30, 1968. Achener, P. Y. (Aerojet-General Corp., San Ramon, Calif. Nuclear Div.). Nov. 1968. Contract AT(04-3)-368. 21p. Dep. CFSTI.

The refractory metal holder of the vapor viscosity apparatus was completed and is being tested. The determination of the vapor thermal conductivity and Prandtl number of potassium was completed. Tentative results of the surface tension of sodium with 40 to 190 ppM oxygen are given. The apparatus for the determination of the thermal conductivity of liquid lithium and sodium at 2200 to 2500°F was fabricated and assembled. The determination of the thermal conductivity of liquid sodium was begun. (G.M.C.)

**30004** (GEMP-1010, pp 13-43) PHYSICAL AND MECHANICAL PROPERTIES OF REACTOR MATERIALS (1503). Conway, J. B.; Flagella, P. N. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.).

Short-term tensile data for wrought, arc-cast molybdenum sheet tested from 25 to 1200°C are presented. The ultimate strength at 650°C was 70.6 kg/mm$^2$ for the stress-relieved condition and 32.7 kg/mm$^2$ for recrystallized material. Initial creep-rupture data obtained at 650 and 750°C are also given. A combined strength–temperature correlation is shown for the same molybdenum sheet from 25 to 2400°C and the influence of recrystallization is shown in the 800 to 1200°C temperature range. Creep-rupture studies of the effect of various purification treatments for six sheets of W-$^{25}$Re-$^{30}$Mo (at. %) were performed. At 1600°C and 4.22 kg/mm$^2$, essentially identical results were obtained for creep resistance, rupture life, and ductility. At 2200°C and 0.562 kg/mm$^2$, significant differences were obtained; the non-purified material was more creep resistant and less ductile. The effect of thoriated tungsten (0.9% thoria) in the W-$^{30}$Re-$^{30}$Mo alloy was investigated. Creep-rupture tests showed that the material has a shorter rupture life at 1600°C than any unthoriated material evaluated, including arc-cast material. Similar results were obtained at 2200°C although low-stress, long-time strengthening was indicated. Stress-rupture and creep results for tantalum, niobium, and the $^{753}$Cb alloy tested at 1600°C in a vacuum of $1 \times 10^{-6}$ torr, are presented. Chemical analysis of tested samples show oxygen contamination proportional to the 0.25 power of the time at temperature, at least to 200 hours. Other interstitial elements remained at low levels. Thermal diffusivity data for AISI 304L stainless steel are presented for the temperature range of 300 to 1100°C. (auth)

**30005** (GEMP-1010, pp 99-147) FAST BREEDER REACTOR ADVANCED FUEL ELEMENT CLADDING FABRICATION (1115). Frank, R. G.; Tarr, C. O. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.).

Preliminary drawing trials of LMFBR size tubing from arc-cast unalloyed molybdenum tube blanks have been successful for both 10 and 40 ppM carbon content material. Supplementary process development studies are nearing completion wherein in-process and final stress-relief temperatures and various reductions in wall thickness of tubes are being evaluated. The objective is to select a structure that will provide an optimum combination of strength and ductility. A double-arc-cast molybdenum ingot was melted from powders which were leached in HCl and decarburized by treating 504 hours at 800°C in hydrogen–water vapor, and a triple electron-beam-melted ingot was melted from as-received commercial powders. The decarburization process as applied to unalloyed molybdenum powders was evaluated. It was observed that the carbon content of molybdenum powders could be reduced to 1 to 4 ppM from approximately 30 ppM by treating the powders 2 to 4 hours at 800°C in hydrogen. It also was observed that molybdenum powders will react with atmospheric carbon. Leaching of the molybdenum powder with either $HNO_3$ or HCl increased the

tendency for carbon adsorption from the atmosphere. Studies are in progress to develop satisfactory procedures for removing rolling lubricants from unalloyed molybdenum sheet prior to stress-relief treatments. Removal of the silicone oil lubricants with acetone followed by a trichlorethylene degrease resulted in the formation of $Mo_2C$ on the sheet surface during stress-relief treatment at 1000°C. Complex detergents (phosphates), alkaline baths, light acid etching, and hydrogen–water vapor atmospheres also were evaluated for their effectiveness in removing lubricants. In the later series, $Mo_3Si$ was observed with the exception of the sheet cleaned in hydrogen–water vapor atmosphere. W-25Re alloy tubes were completed to 0.172 cm OD for thermocouple sheathing. Processing of these tubes included both sinking and mandrel drawing. In order to finish the tubes to size an 1800°C stress-relief treatment was required between two 1450°C treatments to reduce the hardness of the material. Radial cracks still developed in several tubes, however. (auth)

**30006** (GEMP–1010, pp 148-54) PHYSICAL METALLURGY OF FAST BREEDER REACTOR CLADDING MATERIALS AND REFRACTORY METALS (1177). Collins, C. G.; Bohlander, K. M. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.).

Tensile tests completed at various strain rates on 19-9DL alloy specimens showed that various thermal mechanical treatments yielded comparable yield and ultimate tensile strengths and reductions in area but significant differences in elongations at fracture. The most ductile materials were obtained with a double anneal at 1040 and 840°C after room-temperature reduction, and reduction at liquid nitrogen temperature followed by a 980°C anneal. The first creep-rupture tests of pressurized tubes were initiated on specimens of four thermal-mechanical treatments fabricated to nominal LMFBR cladding dimensions (5.59 mm ID by 0.38 mm wall thickness). Heat treatment studies were initiated late in the quarter on Type 316 SS using a vacuum-arc-remelted material ordered to tentative FFTF composition specifications. (auth)

**30007** (GEMP–1010, pp 155-60) ADVANCED LONG LIFE REACTOR FUEL CLADDING AND STRUCTURAL MATERIALS DEVELOPMENT (1119). Robertshaw, F. C.; Bartos, J. L. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.).

Plans for melting 135-kg heats of high-purity Type 316 stainless steel were used to produce two small heats to assess the purity levels attainable. Chemical analyses of the stainless steel are given. A cylindrical button-head tensile specimen of heat M-394 (Cr-6W-0.01Y) was tested at 650°C in the as-extruded (1540°C) condition. The high-strength alloys, M-364 (Cr–15V–0.7Y), M-368 (Cr–1Be–0.56Y), and M-394 (Cr–6W–1Y), were creep rupture tested at 750°C and 2520 kg/cm$^2$ in argon. Results of tests on Type 316 stainless steel are also tabulated. (J.C.W.)

**30008** (GEMP–1010, pp 161-98) EVALUATION OF THE PLASTIC FATIGUE PROPERTIES OF HEAT-RESISTANT ALLOYS (1516). Conway, J. B. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.).

Fatigue data were generated to continue the study of effects of strain wave form and length of hold period on low-cycle fatigue characteristics of AISI 304 stainless steel at 650°C. Data obtained at 0.5 percent strain range continue to show agreement when analyzed in terms of plastic strain range provided data for tension holding only are not included. A new correlation procedure was developed for predicting low-cycle fatigue data based on a knowledge of short-term tensile behavior. A logarithmic plot of plastic strain range versus cycles to failure divided by cycling frequency yields a straight line with a slope of –1. This line passed through the tensile ductility point ploted at an abscissa value corresponding to the tensile ductility divided by the strain rate. Relaxation data obtained in hold-time tests are in good agreement with relaxation data obtained in monotonic tensile relaxation tests at a strain equal to the strain amplitude of the hold-time tests. Analyses of the true stress-versus-strain data for AISI 304, 316, and 348 stainless steel at temperatures to 816°C indicate good agreement with the Voce equation. Data are presented to indicate the variation of the Voce equation constants with temperature. (auth)

**30009** (GEMP–1010, pp 199-231) ADVANCED PRESSURE VESSEL MATERIALS (1521). Robertshaw, F. C.; Stephan, H. R. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.).

Thermal stability tests at 290 and 315°C on $^{12}$Ni–$^{5}$Cr–$^{3}$Mo maraging steel in various conditions of heat treatment for times up to 3000 hours continue to show an asymptotic increase in hardness, indicating that further aging is occurring. Additional weldment studies on the maraging steel and PH13–$^{8}$Mo, using matching filler wire, indicate that aging only, after welding, can effect promising levels of weld efficiency. Initial weldments of the HP $^{5}$Ni–$^{4}$Co–$^{0.20}$C alloy were completed and the welds are sound. A series of dynamic tear (DT) tests were completed on specimens of the $^{12}$Ni maraging steel, PH13–$^{8}$Mo, and Inconel alloy 718. Data obtained generally confirm results obtained in previous Charpy V-notch tests. Low-cycle fatigue testing of the maraging steel and Inconel alloy 718 was begun; end notch failures were encountered. Initial plans were made for plane strain ($K_{Ic}$) fracture toughness testing of program materials. (auth)

**30010** (GEMP–1010, pp 232-59) PHYSICO-CHEMICAL STUDIES OF CLAD $UO_2$ UNDER REACTOR ACCIDENT CONDITIONS (1175). White, J. F. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.).

Dynamic tests of pressurized Zircaloy-4 tubing in a steam atmosphere show four behavior patterns. Tubes pressurized below 0.05 kg/mm$^2$ fail in steam by fracture with less than 34 percent expansion for heating rates below about 50°C per sec. At higher heating rates, erratic behavior was observed including some tubes which expanded only slightly with no evidence of failure. Tubes pressurized at 0.06 kg/mm$^2$ fail in steam by fracture at less than 34 percent expansion at heating rates up to 200°C per sec. Tubes pressurized between 0.07 and 0.08 kg/mm$^2$ fail in steam by either fracture or ductile expansion. The mechanism of failure is very sensitive to the interrelated effects of slight variations in the mechanical properties of the tubing, the internal pressure, the temperature, and the amount of oxidation. Tubes pressurized above 0.08 kg/mm$^2$ and heated in a steam atmosphere at rates in excess of a few tenths of a degree centigrade per second fail by ductile expansion. Dynamic tests on pressurized Zircaloy-4 tubing in an inert (argon) atmosphere show up to 109 percent diametral expansion prior to bursting. Initial tests on programmed heating and cooling cycles during dynamic testing of irradiated Zircaloy-2 tubing show a thermal arrest about 80 to 100°C lower than the $\alpha$-$\beta$ transformation arrest observed for unirradiated Zircaloy. Theoretical considerations on annealing of radiation-induced excess tensile strength in Zircaloy-2 show that it is essentially 100 percent complete in 1 hour at temperatures above 450°C. For dynamic conditions the fractional annealing ($f_a$), absolute temperature (T,°K), and heating rates (r,°C/sec) may be related by $f_a = 1 - \exp [-246.7\ T^2/r \exp (-30{,}000/RT)]$. (auth)

**30011** (GEMP–1010, pp 291-313) FAST BREEDER REACTOR CONTROL, SHIELD, AND REFLECTOR MATERIALS DEVELOPMENT (1220). Van Houten, R.; Kennedy, M. D.; Duderstadt, E. C. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.).

A new diffusion couple test specimen design was developed, evaluated, and approved. The design incorporates a hermetically sealed, thin-wall cylinder of the cladding alloy filled with alternating layers of neutron absorber discs and cladding alloy wafers of varying thicknesses to permit identification of Reservoir-related diffusion couple effects. The capsule is then maintained at external pressures up to 280 kg/cm$^2$ to ensure continuing firm contact of uncontaminated diffusion couple interfaces. Four high-pressure test furnaces, each capable of providing identical pressure–temperature exposures of 50 to 150 test specimens, were made available. More than 100 diffusion couple test specimens are being fabricated and will be placed on test at temperatures of 400 (280 kg/cm$^2$), 600 (280 kg/cm$^2$), 800 (210 kg/cm$^2$), 1000 (42 kg/cm$^2$), and 1200°C. Test specimen compositions include $B_4C$ versus 316 SS, BN versus 316 SS, Ta versus 316 SS, and Ta versus Mo. (auth)

**30012** (INR–961) AN ANALOG STUDY OF STEADY AND UNSTEADY STATE TEMPERATURE DISTRIBUTIONS IN A BERYLLIUM BLOCK IN REACTOR CORE. Strupczewski, Andrzej (Institute of Nuclear Research, Warsaw (Poland)). 1968. 38p. Dep.

The solution of a heat conduction problem in a beryllium moderator block of a nuclear reactor under steady state and transient conditions is presented. The temperature distributions in the block have been computed for the case of the sudden increase of reactivity and the corresponding increase of internal heat sources. The temperature dependence of thermal conductivity and heat capacity of beryllium has been taken into account as well as the temperature dependence of the boundary conditions. The accuracy of about 2% has been achieved. (tr-auth)

**30013** (N–69–20789) SOLUBILITIES OF VANADIUM, TITANIUM, AND ZIRCONIUM IN LIQUID POTASSIUM. Stecura, Stephan (National Aeronautics and Space Administration, Cleve-

land, Ohio. Lewis Research Center). Mar. 1969. 21p. (NASA-TN-D-5093). CFSTI.

The solubility of vanadium in liquid potassium containing less than 20 wt ppM of oxygen between 1012 and 1341°K is about 6 to 70 wt ppM, respectively. The heat of solution for the vanadium solubility is 21 ± 4 kilocalories per mole (87.9 kJ/mole). Titanium and zirconium solubilities in liquid potassium between 1020 and 1341°K are less than 4 and 10 wt ppM, respectively. Vanadium, titanium, and zirconium solubilities were studied in potassium doped with potassium nitrate ($KNO_3$). The data suggest that $KNO_3$ is not a good doping agent for determining the effect of oxygen on the solubilities of transition metals in liquid potassium. (auth) (STAR)

**30014** (N-69-22993) DYNAMIC STRAIN AGING DURING THE CREEP AND TENSILE TESTING OF A MOLYBDENUM-TITANIUM-CARBON ALLOY. Raffo, Peter L. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr. 1969. 26p. (NASA-TN-D-5169). CFSTI.

A study was made of the creep and tensile properties of a Mo-0.82 Ti-0.20 C (at. %) alloy in the temperature range 1800 to 3200°F. A peak in the flow stress-temperature curve was noted for this alloy at 1800°F. The strain rate sensitivity of the flow stress was negative in the temperature range 1500 to 2200°F. The creep rate of this alloy above 2400°F has a stress and temperature dependence equal to that of unalloyed molybdenum. At temperatures below about 2400°F, the creep rate at a given stress depends not only on the stress and temperature, but on the entire preloading history. Precipitation occurs on dislocations in specimens crept at 1800°F. It was deduced that the strengthening effects noted during the creep and short time tests are directly related to carbide precipitation during plastic deformation. Precipitation during deformation has effects associated with the decrease in the mobile dislocation density which leads to a greatly decreased creep rate in a constant stress creep test and an increased work hardening rate in a constant strain rate tensile test. Precipitation during deformation may also decrease the rate of recovery. (auth) (STAR)

**30015** (N-69-23004) MECHANICAL PROPERTIES AND COLUMN BEHAVIOR OF THIN WALL Be-38Al ALLOY TUBING. Rummler, Donald R. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Apr. 1969. 48p. (NASA-TN-D-5145). CFSTI.

The results of an experimental investigation to determine the mechanical properties at room temperature and column behavior of commercially produced Be-38Al alloy tubing are presented. The investigation included tubing in both the as-extruded and annealed conditions. Microhardness measurements and metallurgical studies were also performed. Column-buckling loads were predicted by using the tangent modulus, derived from compressive stress-strain curves, in the inelastic column-buckling equation. (auth) (STAR)

**30016** (NRL-6869) DISLOCATION PIPE DIFFUSION IN SILVER SINGLE CRYSTALS. Vardiman, R. G.; Achter, M. R. (Naval Research Lab., Washington, D. C.). Mar. 25, 1969. 14p. CFSTI.

A chemical sectioning technique has been developed for the measurement of self diffusion in silver at low temperatures. (Silver was chosen because of its well-established high-temperature behavior, and because of the availability of the long-lived isotope $^{110}Ag$.) Layers of 100 Å or less are removed by an iodine reaction, and diffusion coefficients D as low as $2 \times 10^{-17}$ $cm^2/sec$ have been measured. A large enhancement over extrapolated high-temperature values, which has been observed below $T_m/2$, is attributed to dislocation short circuiting. Determination of the pipe diffusion coefficient at the lowest measured temperature, where Harrison's type C kinetics are expected to apply, yields good agreement with the pipe diffusion coefficients $D_p$ calculated from published data obtained by another technique. (auth)

**30017** (ORNL-4403) HIGH-TEMPERATURE SORPTION OF NITROGEN BY Nb-1 PERCENT Zr IN ULTRAHIGH VACUUM. Inouye, H. (Oak Ridge National Lab., Tenn.). May 1969. Contract W-7405-eng-26. 19p. Dep. CFSTI.

The sorption kinetics of nitrogen by a filament of Nb-1% Zr was studied in ultrahigh vacuum to determine the variables that control the contamination rates of refractory metals by the residual gases in vacuum systems. The results are summarized in terms of the sticking probability, $\alpha$, which is defined as the ratio of the sorption rate to the incident rate of the gas at the alloy surface. In the temperature range 800 to 1600°C and at nitrogen pressures between $10^{-9}$ and $10^{-7}$ torr, $\alpha$ was found to be less than 0.10 (i.e., less than 10% of the incident nitrogen was sorbed by the alloy). The value of $\alpha$, which was dependent on the temperature and the pressure and the nitrogen content of the alloy, could be described by the expression, $\alpha = \alpha_0(1 - C_m/C_e)$, where $\alpha_0$ has a maximum value of approximately 0.11, $C_m$ is the mean nitrogen concentration, and $C_e$ is the equilibrium concentration. It was also shown that $\alpha$ was dependent on the diffusivity of nitrogen in the alloy according to the expression $\alpha = \alpha_0[1 - 1.128(Dt/L^2)]$. The diffusivity of nitrogen was determined to be $D = 1.4 \times 10^{-5}$ exp (-42,000/RT). (auth)

**30018** (UCRL-71608) ANALYSIS OF THE EFFECT OF EVAPORATION LOSS OF TRACER ATOMS DURING SURFACE SELF-DIFFUSION. Wolfe, J. R. (California Univ., Livermore. Lawrence Radiation Lab.); Weart, H. W. (Missouri Univ., Rolla). Mar. 14, 1969. 24p. (CONF-690507-1). Dep. CFSTI.

From AIME Spring Meeting, Pittsburgh, Pa.

The effect of radioactive tracer evaporation during surface diffusion experiments was analyzed for the (111) surface of fcc metals. The tracer evaporation flux ($J_E^*$) is compared with the more well-known parasitic tracer flux loss ($J_V^*$) into the bulk. Calculations of the ratio $J_E^*/J_V^*$, based on adatom diffusion on a Terrace-Ledge-Kink (TLK) surface, indicate that evaporation effects must be included in the analyses for several fcc metals. The proposed model and resulting theory verify several recently published experimental observations concerning surface diffusion on iron and nickel and offer a logical explanation of past difficulties with silver surface diffusion experiments using tracer methods. (auth)

**30019** EFFECT OF PRESSURE ON THE TEMPERATURES OF THE MAGNETIC TRANSITION OF SEVERAL COMPOUNDS HAVING THE FORMULA $TCo_3$ IN WHICH T DENOTES A RARE EARTH METAL OF YTTRIUM. Bloch, Daniel; Chaisse, Francis (Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France). Compt. Rend., Ser. B, 268: 660-3(Mar. 3, 1969). (In French).

The variation with pressure up to 6 kbar of Curie points is studied for $YCo_3$, $PrCo_3$, $NdCo_3$, and the balance point of $HoCo_3$. The variation is nonlinear for $YCo_3$, $PrCo_3$, and $ErCo_3$, but it is linear for $ErCo_3$ and $HoCo_3$. (tr-auth)

**30020** STUDY OF THE ANODIC OXIDATION OF TANTALUM USING OPEN-CIRCUIT TRANSIENTS. Ord, J. L. (Univ. of Waterloo, Ont.); DeSmet, D. J. J. Electrochem. Soc., 116: 762-7(June 1969).

The anodic oxidation of tantalum in sulfuric acid was studied by analyzing open-circuit transients applied at intervals along galvanostatic oxidation transients. The dependence of the oxidation current density, i, on the overpotential, V, is expressed by the equation $i = i_0 \exp(V/V_0)$ where $i_0$ and $V_0$ are parameters determined from the data analysis. The parameter $V_0$ is found to vary linearly with the potential during galvanostatic oxidation, while $i_0$ depends on the applied current density. Using this equation relating current density and potential, together with a knowledge of the behavior of the parameters $i_0$ and $V_0$, both the steady-state and transient behavior of this system can be predicted. (auth)

**30021** APPLICATION OF THE CRACK OPENING DISPLACEMENT APPROACH TO THE PREDICTION OF PRESSURIZED TUBE FAILURE. Fearnehough, G. B.; Watkins, B. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Int. J. Fracture Mech., 4: 233-43(Sept. 1968).

A major factor affecting the life of zirconium pressure tubes during the operation of a boiling water reactor of the steam generating heavy water type is the possibility of embrittlement as a result of hydrogen absorption and irradiation damage. The application of fracture mechanics to the failure of flawed tubes is discussed, followed by the results of experiments to determine the validity of the crack opening displacement (COD) approach for predicting tube failure. Calibrations were obtained between the COD and the hoop stress during the pressurization of 5-in dia tubes containing artificially introduced longitudinal defects. The calibrations were used to determine an empirical formula for the plane strain fracture toughness, $K_{Ic}$. Critical COD values were measured on small notched bend specimens machined from burst tubes, and by means of the above calibration they were used to calculate the corresponding tube failure stress. Good agreement with the experimentally determined failure stresses indicated that this small scale specimen can be used to predict the behavior of these tubes used in a steam generating heavy water reactor. (BBB)

**30022** PROPERTIES OF VACUUM-MELTED TUNGSTEN IN THE CAST STATE. Girshov, V. L.; Kopetskii, Ch. V.; Panovko, V. M.; Tsyganova, E. V.; Chuvardinskii, Yu. G. Fiz. Khim. Obrab. Mater., No. 4, 149-55(1967). (In Russian).

Properties of cast tungsten and tungsten alloys with ruthenium, osmium, zirconium, niobium carbide, or titanium were determined directly after melting and also after homogenizing annealing. Castings made by depositing melts on rods previously cleaned by electron beam zone melting were compared with those of tungsten obtained by arc melting in a slag-lined furnace. The tungsten ingots obtained by vacuum arc deposition are characterized by a coarse-grained columnar structure. Tungsten ingots obtained in a slag-lined furnace have a uniform fine-grained structure both length- and crosswise—there is no zone of columnar crystals. The primary macrograins of tungsten are divided into subgrains. The presence of the subboundary is characteristic of tungsten obtained by either type of melting. The subgrain boundaries are shifted and expanded in the high temperature annealing process. The hardness of unalloyed tungsten is 290 to 390 HV. Alloying with ruthenium and osmium reduced hardness and grain size. Alloying with zirconium also reduces grain size but increases hardness somewhat, while alloying with titanium and niobium carbide did not have any significant effect on either hardness or grain size. Technological plasticity indexes of the investigated alloys did not correlate with microstructure and hardness measured at room temperature. Tungsten alloyed with titanium was least resistant to deformation, but introduction of the other alloying elements lowered the technological plasticity of tungsten. (JPRS)

**30023** EFFECT OF BORON ON THE TECHNOLOGICAL AND MECHANICAL PROPERTIES OF CAST HEAT-RESISTANT NICKEL-BASE ALLOYS. Didyk, B. S.; Medovar, B. L.; Pavliychuk, G. A. Tekhnol. Organ. Proizvod., No. 4, 51-2(1968). (In Russian).

To improve the castability and weldability and to reduce the hot cracking susceptibility of complex heat-resistant nickel-base alloys frequently used in weldments consisting of cast elements joint research was conducted on the properties of KhN60MVTYu alloy additionally alloyed with up to 0.60% boron. The new alloys, designated KhN60MVTYuR1, have a two-phase structure consisting of austenite and a boride eutectic. The content of the latter phase increased with increasing boron content. Boron reduced linear shrinkage from 2.25% for boron-free alloy to 1.77% for alloy containing 0.6% boron. Flowability also improved with increasing boron content, but reached a maximum at 0.3% boron. No hot cracks were observed in specimens containing over 0.2% boron. At a boron content of 0.6%, the respective liquidus and solidus temperatures were 1260 and 1225°C compared with 1330 and 1300°C for boron-free alloy. Boron also reduced the grain size of cast metal and prevented the formation of a columnar structure. No hot cracks were detected in the welds or weld-adjacent zones of joints in cast alloys containing 0.3 to 0.6% boron. KhN65MVTYuR1 alloy, heat treated, annealed at 1130°C for 5 hr, air cooled, aged at 850°C for 3 hr, and air cooled, had a tensile strength of 110.8 and 56.4 kg/mm², a yield strength 77.0 and 56.4 kg/mm², an elongation 9.0 and 11.9%, a reduction of area of 11.4 and 34.6%, and a notch toughness of 2.0 and 2.8 kg/cm² at 20 and 900°C, respectively. Corresponding figures for heat-treated rolled EP202 alloy were 110 to 115 and 45 to 52 kg/mm², 63 to 75 and 43 to 50 kg/mm², 18 to 30 and 6 to 12%, 20 to 30 and 8 to 18%, and 6 to 12 and 13 to 15 kg/cm². The 100-hr rupture strength of KhN60MVTYuR1 alloy at 800°C was 27 to 29 kg/mm². It is concluded that this alloy has satisfactory castability and high heat resistance at adequate ductility and notch roughness. (JPRS)

**30024** SILVER-BASE CONTACT ALLOY. Pravoverov, N. L.; Begetova, I. S. Russian Patent 223,352. (In Russian).

A silver-base contact alloy containing beryllium is introduced. To improve the mechanical properties, the corrosion resistance of the contacts and their intermediate resistance, the alloy is supplemented with palladium and cerium while maintaining the other components at the % ratio, 0.1 to 0.3 beryllium, 0.4 to 0.6 palladium, 0.01 to 0.05 cerium, and silver to make up 100%. (JPRS)

**30025** PHASE DIAGRAM OF PLATINUM METALS. Polyakova, V. P. pp 191-200 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka. 1968. (In Russian).

Some features of the reaction of Pt metals with other elements were examined. An analysis of the reactions between Pd and transition metals is given. The changes in properties of Pd were considered in relation to the position in the Periodic Table and the crystal structure of the alloying element. (Metals Abstr.)

**30026** THE HEAT CAPACITIES OF $Al_2O_3$, $UO_2$, AND $PuO_2$ FROM 300 TO 1100°K. Engel, T. K. (Mound Lab., Miamisburg, Ohio). Contract AT(33-1)-Gen-53. J. Nucl. Mater., 31: 211-14(June 1969).

The measured heat capacity values of $Al_2O_3$ and $UO_2$ were within 3% of previous values. The heat capacity of $PuO_2$ increased from 0.0611 to 0.0817 cal/g·°K between 300 and 1100°K, approximately 8 to 10% greater than the values of $UO_2$ over the same temperature range. (auth)

**30027** RADIATION-ENHANCED RELAXATION IN ZIRCALOY-4 AND Zr/2.5 wt PERCENT Nb/0.5 wt PERCENT Cu ALLOYS. Mosedale, D.; Lewthwaite, G. W. (Dounreay Experimental Reactor Establishment, Caithness, Scotland). J. Nucl. Mater., 31: 228-9(June 1969).

The method to deal with a large number of variables such as composition, condition, and stress in a metal is reviewed. The comments on the model previously presented point to the inaccuracies of certain assumptions. The original report on radiation-enhanced relaxation deals with Zircaloy-4 and Zr–Nb–Cu alloys. (J.C.W.)

**30028** SOME IMPROVEMENT IN INCONEL-718 BRAZING TECHNOLOGY FOR NUCLEAR REACTOR. Amato, I.; Ravizza, M. (FIAT, Turin). Energ. Nucl. (Milan), 16: 397-9(June 1969).

Inconel-718 can be satisfactorily brazed in hydrogen or in vacuum at 1025°C using Nicrobraz-50 as brazing alloy. An aging treatment of 720°C for 8 hours gives mechanical properties acceptable for grids operating in pressurized water reactors. In order to avoid the presence of porosities or inequalities in the brazed joint, an electroplating with nickel is necessary. A shear resistance of 55 kg per millimeter of brazed joint length was obtained for plated specimens. A 20% decrease in the shear resistance was observed in unplated specimens. (auth)

**30029** RELATION BETWEEN TEXTURE AND HARDNESS ANISOTROPY IN SOME BERYLLIUM- AND ZIRCONIUM-ALLOY PRODUCTS. Mishima, Yoshitsugu; Ishino, Shiori (Tokyo Univ.). Tokyo Daigaku Kogakubu Kiyo, A, No. 6, 48-9(Dec. 1968). (In Japanese).

Orientation dependence of Knoop hardness has been measured on extruded beryllium, beryllium–calcium alloys, and on three different lots of Zircaloy-2 tubes. The hardness was measured on three mutually perpendicular planes of the specimens as a function of the angle between the particular direction of the specimen surface and a longer axis of the Knoop indenter. The observed orientation dependence is explained by texture data independently obtained by x-ray. The reverse procedure of obtaining texture from hardness anisotropy is discussed. (auth) (NSA of Japan)

**30030** THE EFFECT OF FABRICATION VARIABLES ON THE CREEP-RUPTURE PROPERTIES OF MOLYBDENUM-BASE ALLOYS. Stephenson, R. L. (Oak Ridge National Lab., Tenn.). Trans. Met. Soc. AIME, 245: 997-1001(May 1969).

The effect of fabrication variables on the creep-rupture properties of TZM (Mo–0.5% Ti–0.08% Zr–0.03% C), Nb–TZM [Nb-modified TZM(Mo–1.5% Nb–0.5% Ti–0.8% Zr–0.05% C)], and TZC (Mo–1.2% Ti–0.25% Zr–0.15% C) has been studied at 982, 1093, 1204, and 1315°C for rupture times up to 1000 hr. The creep tests were performed in vacuum creep furnaces, employing cold-trapped oil-diffusion pumps, operating at pressures $\leq 2 \times 10^{-7}$ torr. After-test chemical analyses showed no significant changes in interstitial content. The creep-rupture properties of TZM, fabricated according to current mill practice, were determined in the stress-relieved and in the recrystallized conditions to provide control data. Specimens of TZM, Nb–TZM, and TZC fabricated according to each of two experimental fabrication schedules were then tested. The schedules differed in terms of in-process annealing temperatures and warm-working temperatures. The data make several conclusions evident. Fabrication variables do indeed have a profound effect on the long-time creep-rupture properties of molybdenum alloys. Strengths of these alloys compare very favorably with those of other refractory metal alloys in the temperature range studied. (auth)

**30031** EFFECT OF 0.5 wt pct Cu ADDITION ON THE QUENCH-AGING TRANSFORMATIONS IN Zr–2.5 wt pct Nb (Cb) ALLOY. Tangri, K.; Chaturvedi, M. (Univ. of Manitoba, Winnipeg). Trans. Met. Soc. AIME, 245: 991-5(May 1969).

The addition of 0.5 wt % Cu to Zr-2.5 Nb alloy increases the as-quenched hardness of the hexagonal martensitic $\alpha'$ phase, produced by water-quenching bcc $\beta$–Zr phase, by about 35%. This strengthening has been attributed to the solid-solution hardening of the matrix. On aging ternary martensite, $\alpha'$ phase reverts to equilibrium $\alpha$ and $Zr_2Cu$ and $\beta$–Nb precipitate out, mainly at the twin and

grain boundaries, causing a secondary hardening of the matrix. (auth)

**30032** GLIDE ON HIGH INDICES SLIP PLANES IN TUNGSTEN. Fabiniak, T. J.; Balow, R.; Dodd, R. A. (Univ. of Wisconsin, Madison). Trans. Met. Soc. AIME, 245: 1140-1 (May 1969).

Results of investigations show that slip in tungsten can occur on planes of high indices and not necessarily on nonparallel {110} planes. Only {110} slip plane was identified in the experiment; {112} did not operate. This could be related to a localized high temperature zone agreeing with the suggestion that high indices planes operate more readily at high temperature; however, local conditions may have caused high resolved shear stresses on the operating planes. (F.S.)

**30033** TECHNICAL APPLICATIONS FOR OXIDE DISPERSION-STRENGTHENED MATERIALS. Ault, G. Mervin (Lewis Research Center, Cleveland); Burte, H. M. Met. Soc. Conf., 47: 3-57(1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

An analysis is presented of areas of applicability for dispersion strengthened materials. Developmental methods are also discussed and it is noted that in reporting research results care should be exercised in describing processing and composition and in relating observed behavior and structure at the optical and suboptical levels. (J.R.D.)

**30034** THE ENTHALPY OF SOLID TUNGSTEN FROM 2800°K TO ITS MELTING POINT. Leibowitz, L.; Chasanov, M. G.; Mishler, L. W. (Argonne National Lab., Ill.). Trans. Met. Soc. AIME, 245: 981-4(May 1969).

A drop calorimeter system is described for use in measuring enthalpies to 3600°K. Data are presented for tungsten between 2800 and 3600°K. The enthalpy of tungsten in cal per mole between 2000 and 3600°K can be represented by the equation $H_T^\circ - H_{298}^\circ = -1.7622 \times 10^3 + 5.7772T + 8.9861 \times 10^{-6}T^2 + (7.7249 \times 10^3)/T$ where T is in degrees Kelvin. A tabulation of computed values is presented for heat capacity, entropy, and free energy function. (auth)

**30035** PREDICTION OF CREEP COLLAPSE PRESSURES AND TIMES FOR NUCLEAR FUEL CLADDING. Howl, D. A.; Moore, B. (United Kingdom Atomic Energy Authority, Springfields, Eng.). J. Brit. Nucl. Energy Soc., 8: 103-8(Apr. 1969).

A method is described for predicting the external pressure necessary for the creep collapse of a thin-walled tube to occur in a specified time, or the time at which creep collapse of the tube occurs under a specified pressure. The method is based upon that previously used for predicting instantaneous collapse pressure, and uses, in the usual collapse equation, the effective reduced modulus obtained from an isochronous stress/strain curve. Predictions are in good agreement with experimental results. (auth) (UK)

**30036** CREEP FAILURE MODES IN ARC-CAST AND POWDER METALLURGY TUNGSTEN. Rau, R. C.; Williams, F. T. Jr. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 173-7(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

Microstructural investigations, using optical and replica electron microscopy, were used to characterize the modes of high temperature creep deformation and failure in high purity arc-cast and powder metallurgy tungsten. These observations indicate that whereas arc-cast material deforms in a ductile fashion and fails transgranularly, powder metallurgy material is relatively brittle and fails intergranularly by the formation and link-up of creep cavities. At lower temperatures (<2000°C) these cavities were irregular in shape and tended to be flattened along the grain boundaries, while at higher temperatures the cavities exhibited polyhedral shapes. Measurements of the creep porosity present in the powder metallurgy samples accounted for approximately 16% of their total deformation. Although these studies failed to show any evidence of precipitation which might explain the basic difference in failure mechanisms of the two types of tungsten, the occurrence of sintering pores in the powder material probably contributes to its embrittlement. (auth)

**30037** PINNING OF FLUXOIDS BY DISLOCATIONS IN NIOBIUM SINGLE CRYSTALS. II. EFFECT OF TEMPERATURE AND MAGNETIC FIELD. Freyhardt, Herbert (Univ., Goettingen, Ger.). Z. Metallk., 60: 409-12(May 1969).

In dislocated niobium single crystals the interaction force $p_v$ (volume average) between fluxoids and dislocations was experimentally investigated as a function of field B and temperature T. Using a statistical theory developed by R. Labusch, the interaction force $p'_{max}$ of the single event—one fluxoid crossing one dislocation—was determined and compared with the predictions of an elastic model for $p'_{max}$. It was found that $p'_{max}$ vanishes linearly for $B \rightarrow B_{c2}$ and $T \rightarrow T_c$. (auth)

**30038** BERYLLIUM-VACANCY INTERACTIONS IN Al-BASED ALLOYS. Griffiths, Leonard B. (P. R. Mallory and Co., Inc., Burlington, Mass.). Scr. Met., 3: 289-90(May 1969).

The effects of aging at 240°C on the yield stress of an Al–0.9% Mg–0.9% Si–0.5% Be alloy and a beryllium-free alloy are compared. The occurrence of beryllium-vacancy interactions in aluminum-based alloys is noted. (G.M.C.)

**30039** STATISTICAL METHOD FOR THE STUDY OF FRICTION AND WEAR IN VACUUM. Podlaseck, S.; Shen, H. K. (Martin Marietta Corp., Denver). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ. No. 431, 272-314(1967).

From Annual Meeting of American Society of Lubrication Engineers, Toronto, Ontario, Canada. See ASTM-STP–431; CONF-670555.

The friction forces involved in the sliding of unlubricated metal systems were characterized. The experimental apparatus consisted of a pin-on-disk friction apparatus capable of operation environmental pressures of 760 to $10^{-8}$ torr. Sliding speeds were approximately 1 cm/sec, and normal loads were varied from 100 to 300g. Friction data were obtained for similar metal couples of high purity aluminum, OFHC copper, titanium, magnesium, aluminum, tool steel, stainless steel, and niobium alloys. Test data were obtained for different running times in the range 0 to 500 revolutions in air and vacuum for each metal couple. The friction force peaks from each test run were sorted into intervals of equal magnitude by means of a computer program and then plotted in the form of a frequency distribution. From these friction force distributions, it was possible to see clearly the range of friction values occurring in a given test, the most probable value of the friction force, and the total number of friction force peaks, giving a measure of the smoothness of sliding of a given combination of metals. Differences in the sliding mode can be seen quite clearly as a function of running time or as environmental pressure is varied, even in those instances where the friction coefficient, $\mu$, did change. Integration of the friction force distributions and comparison with the volume wear rates for different running times yielded good correlation for most of the metals tested. (auth)

**30040** THE INFLUENCE OF CRYSTAL STRUCTURE, ORIENTATION, AND SOLUBILITY ON THE ADHESION AND SLIDING OF VARIOUS METAL SINGLE CRYSTALS IN VACUUM ($10^{-11}$ TORR). Buckley, D. H. (Lewis Research Center, Cleveland). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ. No. 431, 248-71(1967).

From Annual Meeting of American Society of Lubrication Engineers, Toronto, Ontario, Canada. See ASTM-STP–431; CONF-670555.

Friction and adhesion characteristics were measured in vacuum ($10^{-11}$ torr) for various metal single crystals. The (100), (110), and (111) planes of copper, the (111) plane of nickel, the (0001) plane of cobalt, and the (110) plane of tungsten were studied. Experiments were conducted with matched planes and directions in contact as well as mismatched orientations of copper. The (111) plane of copper was also examined in contact with nickel, cobalt, and tungsten crystals. Measurements included adhesion before sliding, friction during sliding, and adhesion after sliding. The results indicate that sliding markedly increases the adhesion of clean metals in contact. The friction and adhesion of copper is highly anisotropic. Adhesion was observed for the insoluble couple-copper-tungsten after sliding. Crystal structure was found to influence adhesion and friction. (auth)

**30041** FLIGHT REACTOR MATERIALS DEVELOPMENT, SELF-WELD STUDIES. Kellogg, L. G. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ. No. 431, 149-80 (1967).

From Annual Meeting of American Society of Lubrication Engineers, Toronto, Ontario, Canada. See ASTM-STP–431; CONF-670555.

The environmental conditions imposed by nuclear reactors operating in space provide opportunity for surfaces on contact to weld together. A two-phase test program was conducted to determine what material combinations have the least adhesion or are least likely to self-weld when they are in contact under load for long periods of time at high temperature and ultrahigh vacuum. The first phase of the program involved screening tests of mechanical

materials selected for reactor design. The screening test data indicate that in order to minimize adhesion some contaminant film must be placed between the two surfaces. All data are tabulated showing material combination, test temperature, time in test, interface load, adhesion force measured, and the greatest torr value of pressure obtained during the test. The second phase covers eight tests of Type 316 stainless steel in contact with beryllium. Four of the tests were run for 5000 hr and four for 10,000 hr. In the groups of four, two each were coated with a thin film of colloidal graphite and two were bare metal. The data indicate that in all cases where the contacting surfaces were coated the adhesion was very small or immeasurable. The uncoated, bare surfaces grossly adhered to each other from contact welding. Large quantities of beryllium were pulled out and transferred to the stainless steel during separation. Photographs illustrate the damage. The application of contaminant films to the SNAP 10A nuclear reactor to successfully prevent or minimize adhesion after long-term exposure to simulated space environments is illustrated. To simulate the required environmental conditions in which to conduct the tests, it was necessary to design and fabricate a new test facility. The equipment and procedures used are discussed to provide insight into evaluation of the data. (auth)

**30042** ADHESION OR COLD WELDING OF MATERIALS IN SPACE ENVIRONMENTS. Symposium, Toronto, Ontario, Canada, 1–2 May 1967. Philadelphia, American Society for Testing and Materials, 1967. 327p. $12.75. (ASTM-STP–431; CONF-670555).

A total of 17 papers was presented at the meeting. A separate abstract was prepared for each of 3 papers. Papers for which no abstracts were prepared are concerned with adhesion and friction of metals and the effects of high vacuum and simulated space environments on the adhesion and friction of metals. (G.M.C.)

*For abstracts of individual papers see: 30039–30041.*

**30043** VOLUME AND GRAIN-BOUNDARY DIFFUSION IN 20 Cr/25 Ni/Nb STAINLESS STEEL. Smith, A. F.; Gibbs, G. B. (Central Electricity Generating Board, Berkeley, Eng.). Metal Sci. J., 3: 93-4(May 1969).

Standard radiotracer techniques were used to measure the volume-diffusion rates of Cr and Ni in a 20 Cr/25 Ni/Nb austenitic steel in the temperature range 840–1290°C. Within the limits of experimental uncertainty, the results were described by $D_{Cr} = 0.19 \exp(-58.8 \times 10^3/RT)$, $D_{Ni} = 4.06 \exp(-67.5 \times 10^3/RT)$. Grain-boundary-diffusion measurements were made in the range 550–900°C. The diffusion rates of Cr and Ni isotopes were not significantly different from previously reported values for Fe. Combining the data for all three elements gave a mean Arrhenius equation $\delta D_B = 1.5 \times 10^{-7} \exp(-44 \times 10^3/RT)$. (auth) (UK)

**30044** INTERNAL FRICTION OF ALLOYED MOLYBDENUM. Busalov, Yu. E.; Kopetskii, Ch. V.; Kop'ev, I. M.; Smolyakova, L. G. Fiz. Khim. Obrab. Mater., No. 1, 117-18(Jan.-Feb. 1968). (In Russian).

The effect of traces of alloying elements belonging to the VIII group of the Periodic Table on the internal friction, dislocation structure, and tendency to cold shortness of Mo wire was studied. The amplitude dependence of the internal friction of samples containing various quantities of alloying elements was plotted, and the energy associated with the interaction between dislocations and interstitial impurities was determined. The results are considered from the point of view of improving the properties of Mo wire by adding traces of other elements. (Metals Abstr.)

**30045** TRANSVERSE KERR MAGNETO-OPTIC EFFECT AND OPTICAL PROPERTIES OF TRANSITION METAL–RARE-EARTH ALLOYS. Ferguson, P. E. (Magnavox Research Labs., Torrance, Calif.); Romagnoli, R. J. J. Appl. Phys., 40: 1236-8 (Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

The transverse Kerr magneto-optic effect and optical properties have been measured in Fe and $GdFe_3$ for the optical wavelength range of 0.35 to 1.0 $\mu$. The metals were evaporated onto the base of glass prisms at $1 \times 10^{-9}$ mm Hg vacuum. The properties were measured at two angles of incidence. The maximum transverse Kerr effect at a 60° angle of incidence is 5.55% for Fe and occurs at 0.7 $\mu$. The maximum transverse Kerr effect at a 60° angle of incidence for $GdFe_3$ is 1.9% and occurs at 0.65 $\mu$. From the experimental measurements, the spectral distribution of the diagonal and off-diagonal components of the dielectric tensor were determined. Structure indicative of optical transitions was found in the absorptive parts of both components for $GdFe_3$ but was absent for Fe. A discussion is given relating this structure to the conduction electrons in Gd. (auth)

**30046** NEW PERMANENT MAGNET MATERIALS CONTAINING RARE-EARTH METALS. Nesbitt, E. A. (Bell Telephone Labs., Murray Hill, N. J.). J. Appl. Phys., 40: 1259–65 (Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

Previously, most basic magnetic properties of the hexagonal intermetallic compounds involving the rare-earth (RE) and 3-d transition elements were reported in the literature. In addition, some of these compounds were investigated by various workers for permanent magnet properties by grinding ingots of the compounds into very fine powder. Recently, new permanent magnet materials were discovered which were based mostly on the hexagonal intermetallic compounds $Co_5RE$. Replacement of cobalt with copper in some of these rare-earth compounds resulted in solid materials having substantial permanent magnet properties. An outstanding feature of these alloys is their high value of intrinsic coercive force. High-energy product alloys were found in the $Co_{5-x}Cu_xSm$ and $Co_{5-x}Cu_xCe$ systems with iron additions. Small pieces of $Co_{3.5}Fe_{0.4}Cu_{1.35}Sm$ exhibited $B_R$ = 6450 G, $B^Hc$ = 4000 Oe, and $(BH)_m = 9 \times 10^6$ G Oe. Also, small pieces of $Co_{3.5}Fe_{0.5}CuCe$ exhibited $B_R$ = 5100 G, $B^Hc$ = 3500 Oe, and $(BH)_m = 5.2 \times 10^6$ G Oe. In general, these alloys are prepared by inert-electrode arc melting, resulting in a relatively rapid freezing from the molten state. The samples are then given a low-temperature anneal. Cross sections of the specimens show microstructural directionality which is a result of freezing in a direction normal to the cold surface of the hearth. These directional effects appear to be associated with the directional magnetic properties that are important because of the high crystal anisotropy of the alloys. When a specimen of the composition $Co_{3.45}Fe_{0.25}Cu_{1.35}Sm$ was annealed at 1100°C and examined by optical-microscope and electron-probe techniques, particles rich in $Co_5Sm$ were observed to be embedded in a $Cu_5Sm$-rich matrix. The iron appeared largely in the cobalt-rich phase. The cobalt-rich particles were approximately $2.5 \times 10$ $\mu$. Further work is in progress to improve directional properties and thus further improve the magnetic properties. (auth)

**30047** ANOMALOUS AND ORDINARY HALL EFFECT IN TERBIUM. Rhyne, J. J. (Naval Ordance Lab., White Oak, Md.). J. Appl. Phys., 40: 1001-3(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

The anomalous and ordinary Hall coefficients $R_s$ and $R_0$ defined by the relation $\rho_H \equiv R_0B + R_s4\pi M$ have been obtained for single-crystal Tb in both ordered and paramagnetic states. Results for the component of the Hall resistivity $\rho_H$ characterized by H (and M) in the basal plane ($10\bar{1}0$ easy axis in Tb) show that $\rho_H$ is linear in H above $T_N$ and exhibits a strong temperature dependence which is almost entirely due to that of the magnetic susceptibility. $R_s$ is found equal to $-40.4 \times 10^{-12}$ $\Omega \cdot$ cm/G and temperature independent. Below $T_N$, the anomalous coefficient found from the saturation Hall resistivity reverses sign, passes through a maximum near 140°K (where $R_s = +22.4 \times 10^{-12}$ $\Omega \cdot$ cm/G) and falls to 0 below 30°K. Possible mechanisms for this unique sign reversal in $R_s$ are discussed. The T-independent nature of $R_s$ above $T_N$ plus a linear dependence of $R_s$ on the derived magnetic resistivity below 120°K indicates that thermal disorder of the 4f spin system is the dominant scattering mechanism in the Hall effect. The normal coefficient is essentially temperature-independent above approximately 260°K ($R_0 = -1.0 \times 10^{-12}$ $\Omega \cdot$ cm/G) and below 90°K. At intermediate temperatures, $R_0$ rises to a positive maximum of $+8.8 \times 10^{-12}$ $\Omega \cdot$ cm/G at 205°K. Hall resistivity data above $T_N$ with H along ⟨0001⟩ directions (second independent component in hcp symmetry) give significantly larger values of $R_s$ and $R_0$ reflecting the Fermi surface anisotropy. (auth)

## *Structure and Phase Studies*

*Refer also to abstracts 28811, 30029, 30031, 30032, and 30120.*

**30048** (BM-RI–7186) FIELD FREEZING OF A CERIUM–IRON ALLOY. Murphy, James E.; Morrice, E.; Henrie, T. A. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). Oct. 1968. 14p.

Field freezing was used to effect the redistribution of the components in a cerium-12.5-atomic-percent-iron alloy. The application of the electric field caused the iron to migrate toward the anode. A field intensity of 0.04 V/cm and a current density of 240 A/cm$^2$ were used. The conditions that yielded the greatest redistribution of alloy components were a small thermal gradient along the specimen (from 5°C/cm to 10°C/cm) and a very slow freezing rate (0.15 cm/hr). Under these conditions it was possible to process specimens of ½-inch diameter as compared with

the capillary-size specimens used by most previous investigators. (auth)

**30049** (BNWL-981) MICROSTRUCTURES OF DEFORMED ALPHA PLUTONIUM. Nelson, R. D.; Dahlgren, S. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1969. Contract AT(45-1)-1830. 13p. Dep. CFSTI.

The effect of temperature, strain rate, and total strain on the deformation mode of high purity cast alpha plutonium was determined. Deformation was predominantly by grain boundary sliding at 110°C and at a strain rate of $10^{-4}$ per min, whereas slip was the major deformation mode at −10°C and $10^{-1}$ per min. Deformation at intermediate temperatures and strain rates was by a mixture of grain boundary sliding and slip. Recrystallization occurred concurrently with deformation only after a critical strain was reached. The critical strain decreased with increasing temperature and was independent of strain rate in the range of $10^{-1}$ to $10^{-4}$ per min. Strains of 14, 6, and 3% were required at 105, 110, and 120°C, respectively, before recrystallization started. Deformation by twinning was insignificant. (auth)

**30050** (UCRL-18727) THERMODYNAMIC STABILITY OF CERTAIN INTERMETALLIC COMPOUNDS MADE FROM TRANSITION ELEMENTS. Wengert, Paul Richard (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1969. Contract W-7405-eng-48. 118p. Dep. CFSTI.

Thesis.

The Zr compounds of Re, Ru, Os, Rh, Ir, Pd, Pt, Ag, and Au were studied. Limits and estimates of the Gibbs free energy of formation of these compounds are determined by observing high temperature reactions of C and ZrC with the above elements and with their Zr compounds. $ZrRh_3$, $ZrIr_3$, $ZrPd_3$, and $ZrPt_3$ exist in equilibrium with C and ZrC and have $\Delta F^\circ < -11.5$ kcal/g-atom of compound calculated at 298°K. C and ZrC exist in equilibrium with the Ru (0.75 at. % Zr), Os (≤0.06 at. % Zr), Ag (liquid, ≤0.05 at. % Zr), and Au (liquid, 9.5 ± 3.5 at. % Zr) phases at 1500°C. The $\Delta F_f^\circ$ ($ZrRu_2$) is calculated from the equilibrium data to be −13.6 ± 0.9 kcal/g-atom at 1500°C and $\Delta F_f^\circ$ ($ZrAu_4$) is calculated to be −7.93 ± 0.35 kcal/g-atom at 1000°C. The activity coefficients of Zr ($\gamma_{Zr}$) in the limit of 0% Zr are calculated from the three phase equilibria. No ternary compounds were observed for the above systems. In the case of the C−Zr−Re system, a molar ratio of Zr to Re of 19.0 to 81.0 was found in the hcp Re phase in the presence of C and ZrC indicating that this phase extended into the ternary system; therefore, no thermodynamic information could be determined by this method for the Zr−Re binary system. The lattice parameters of the expanded hcp Re phase are determined: a = 2.7810 ± 0.0004 Å, C = 4.4590 ± 0.0008 Å. Miscellaneous properties of the binary alloys are given. Reactions of carbides, borides and nitrides with transition elements reported by other authors are reviewed. Limits on $\Delta F_f^\circ$ of the following compounds are calculated at 298°K: $ZrRh_3$, $ZrIR_3$, $HfRh_3$, $HfIr_3$, $ThIr_3$, $ThRh_2$, $ThAu_3$, $NbPt_3$, $NbIr_3$, $NbRe_{3\pm x}$, $TaPt_3$, $UIr_3$, $URh_3$, $U_3IrC_2$, $U_2RhC_2$, and $UAu_3$. The Engel and Brewer concepts of crystal structure and bonding are included. (auth)

**30051** MICROSTRUCTURE OF SUPERALLOYS. Kotval, P. S. (Union Carbide Corp., Indianapolis). Metallography, 1: 251-85(Jan. 1969).

Studies that contribute to an increased understanding of the microstructure of nickel- and cobalt-base superalloys are discussed. Emphasis has been placed on the interaction between imperfections and precipitates that cannot be studied by x-ray and replica methods. The effects of matrix stacking fault energy on the dislocation substructure and the role of different dislocation substructures in the nucleation of precipitates are summarized. Attention has been given to the intragranular precipitation of MC carbides in association with stacking faults in nickel-base alloys. Recent data on the behavior of $\gamma'$-phase in simpler nickel-base alloy systems are discussed with respect to the possible application of these results in understanding the behavior of commercial $\gamma'$-bearing superalloys. Finally, brief consideration is given to recent studies of order-disorder reactions in nickel-base alloys. (auth)

**30052** STRESS GENERATION DURING HIGH-TEMPERATURE OXIDATION. I. OXYGEN SOLUTION EFFECTS. Pawel, R. E.; Campbell, J. J. (Oak Ridge National Lab., Tenn.). J. Electrochem. Soc., 116: 828-32(June 1969).

The flexure of thin rectangular specimens of tantalum and niobium oxidizing on one side at 800°C was measured at several oxygen pressures. In these experiments, the oxygen pressure and oxidation time were generally kept small enough to prevent excessive oxide formation, and the oxygen diffusion distances were of the same order as the specimen thickness. For both oxidation and annealing experiments, the observed flexure behavior under these conditions could be correlated with that predicted on the basis of changes in the oxygen concentration gradients in the specimen. The results have helped to establish further some of the important characteristics of stress generation initiated by the dissolution of oxygen into the surface layers of a metal during oxidation. (auth)

**30053** STUDY OF THE DEFORMATION OF POLYCRYSTALLINE BERYLLIUM DURING COMPRESSION. Finkel, V. A.; Papirov, I. I. (Physical-Technical Inst., Kharkov). Sov. Phys.-Solid State (Engl. Transl.), 10: 2782-3(May 1969).

Translated from Fiz. Tverd. Tela, 10: 3497-9(Nov. 1968).

The structure of polycrystalline Be was determined by the x-ray back-reflection method. The dependence of the interplanar spacings d(112) and d(201) on load for both slow and fast loadings show three regions of different behavior: (1) at 0 to 10 or 15 kg/mm², the spacings increase with load; (2) at 15 to 65 kg/mm², they decrease with load; and (3) at >65 kg/mm², they start to increase again. The cases of elastic and plastic deformation are considered separately. (D.L.C.)

**30054** TECHNIQUES OF METALS RESEARCH. VOLUME II. TECHNIQUES FOR THE DIRECT OBSERVATION OF STRUCTURE AND IMPERFECTIONS. PART 2. Bunshah, R. F. (ed.). New York, John Wiley and Sons, Inc., 1969. 513p. $24.95.

Microscopic, diffraction, and autoradiographic techniques for study of structure and imperfections in metals and alloys are presented. Special techniques for study of plastic deformation and fracture are included. (J.C.W.)

**30055** DIAGRAMMY SOSTOYANIYA METALLICHESKIKH SISTEM. OBZOR ISSLEDOVANII. (Diagrams of the Metallic System Phases. Review of Research). Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. 324p.

Forty-six articles are presented on phase diagrams of high-melting metals of the Periodic Table, including rhenium, rare-earths, platinum, and light metals. A separate abstract was prepared for each of thirty-one articles. The remaining fifteen articles were not within the scope of NSA. (G.M.C.)

*For abstracts of individual papers see: 29953, 29989, 30025, 30056–30077, and 30178–30183.*

**30056** PHASE DIAGRAMS OF VANADIUM BINARY SYSTEMS. Efimov, Yu. V. pp 12-25 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

Experimental data are given for binary systems of V with other elements. The effects of the Hildebrand criteria, the Mott number, structural, dimensional, electrochemical, and temperature factors on the reaction of components of these systems in the liquid and solid states illustrated features of the structure of the phase diagrams of the binary V systems in relation to the position of the second component in the Periodic Table. (Metals Abstr.)

**30057** PHASE DIAGRAM OF TANTALUM. Tsyganova, I. A.; Tylkina, M. A. pp 28-38 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

A study was made of certain regularities in the reaction of Ta with transition metals of Groups IV through VIII of the Periodic Table. Because of the low natural reserves of Ta, consideration is given to the partial replacement of Ta in alloys by less scarce metals, mainly Nb. Suggestions are made as to future directions of research in the study of new Ta-base alloys with special physico-chemical properties. (Metals Abstr.)

**30058** PHASE DIAGRAM OF THE TANTALUM–VANADIUM–ZIRCONIUM SYSTEM. Tararaeva, E. M.; Ivanov, O. S. pp 38-52 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

The Ta−V−Zr ternary system was studied along three radial sections from each corner of the diagram with ratios of the components 1:3, 1:1, and 3:1 using microstructural analysis, hardness, microhardness, x-ray, dilatometric, contactless differential analysis, and mp determinations by electron-beam melting. Specimens were isothermally annealed at 1350, 1250, 1200, 1050, 900, 830, and 750°C and quenched in ice water. The maximum solubility of components in the Ta, V, $\beta$−Zr, and $\alpha$−Zr solid solutions was determined. From the data of the binary phase diagrams, 7 isothermal, and 9 polythermal sections, a polythermal phase diagram of the Ta−Zr−V ternary system was established in the form of a projection on the plane of the concentration triangles over the whole temperature range and the scheme of mono- and nonvariant equilibria in this system compiled. In the ternary system two nonvariant equilibria were found: at 1275 and 775°C. (Metals Abstr.)

**30059** IMPROVEMENTS IN THE NIOBIUM–ZIRCONIUM PHASE DIAGRAM. Ivanov, O. S.; Raevskii, I. I.; Stepanov, N. V. pp 52-7 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

In the Nb–Zr system the distribution of the two-phase region ($\beta_{Nb} + \beta_{Zr}$) in relation to the alloy purity and gas contamination has been checked, mainly by x-ray analysis. This has been done to examine other published work that claims that this is a simple system similar to that of Nb–Ti, with the coring of the $\beta$ solid solution below 975°C caused by contamination by O and N. Two series of alloys, containing Zr 5 to 80 at.% were studied: prepared (i) in an arc furnace in Ar and (ii) in an electron-beam furnace at $10^{-5}$ torr. Both series were homogenized at $10^{-5}$ torr at 1500°C for 3 to 5 hr and then deformed 90 to 96%. The alloys were then annealed to the equilibrium condition in double quartz ampoules at 1050 to 600°C and quenched in ice-water. After quenching from 950 to 640°C the alloys showed coring in two Nb($\beta_{Nb}$)-bases solid solutions and in the Zr-base ($\beta_{Zr}$)solution. The position of the curves bounding the two-phase ($\beta_{Nb} + \beta_{Zr}$) region was determined. It is concluded that in the Nb–Zr system the breakdown of the $\beta$ solid solution below 975°C is mainly caused by the physico-chemical properties of the components of the system, i.e., the dimensional differences of Zr and Nb atoms. 12 ref. (Metals Abstr.)

**30060** THE REACTION OF GROUP VIA METALS WITH HAFNIUM, RUTHENIUM, AND OSMIUM. Shurin, A. K. pp 79-81 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

The reactions of the Group VIA metals (Cr, Mo, and W) with Hf, Ru, and Os were studied. The Hf–Cr diagram and partial isothermal sections at 1500, 1800, and 2150°C for the ternary system W–Mo–Hf are given. The phase diagrams of Hf–Mo, Cr–Ru, and Cr–Os were improved and the W–Hf diagram constructed earlier was confirmed. (Metals Abstr.)

**30061** A STUDY OF THE PHASE DIAGRAMS OF MAGNESIUM-BASE ALLOYS. Drits, M. E.; Sviderskaya, Z. A.; Padezhnova, E. M. pp 95-106 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

A study was made of phase diagrams of Mg-base alloys with particular reference to binary and ternary alloys with rare, rare-earth, alkali, and alkali-earth metals. Some refractory metals that have not so far been widely used for alloying with Mg were also included. Data are given for the binary diagrams of Mg with Ce, Nd, Gd, Th, Sc, and Y; the ternary systems Mg–Mn–Ca, Mg–Mn–Al, Mg–Mn–Ce, Mg–Mn–Th, Mg–Mn–Nd, Mg–Nd–Ni, Mg–Nd–Al, Mg–Th–Zr, Mg–Li–Ag, Mg–Li–Al, and Mg–Li–Zn; and the quaternary system Mg–Mn–Al–Ca. (Metals Abstr.)

**30062** A STUDY OF THE PHASE DIAGRAM OF ALUMINIUM-BASE ALLOYS. Drits, M. E.; Kadaner, E. S.; Turkina, N. I. pp 106-18 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

Recently obtained data are presented for the phase diagrams of Al with Li, Sc, Ti, V, Cr, Mn, Y, Zr, Nb, Mo, Hf, Ta, W, Re, La, Ce, and Nd. Data are given for the nature of the phase equilibria in the ternary systems Al–Cu–Li, Al–Cu–Cd, Al–Mn–Li, Al–Mn–Cd, Al–Si–Zr, Al–Cu–Ce, Al–Mn–Ce, Al–Ag–Mg, Al–Si–Ce, and also for isothermal sections of the quaternary systems Al–Cu–Mn–Li and Al–Cu–Mn–Cd. The diagrams for Al with transition elements show certain general characteristics, e.g., a low solubility of the second component in Al, and the presence of a peritectic reaction at the Al end which takes place, as a rule, at a temperature close to the melting point of Al. (Metals Abstr.)

**30063** PHASE DIAGRAMS OF THE GROUP IVA METALS: TITANIUM, ZIRCONIUM, AND HAFNIUM. Kornilov, I. I.; Budberg, P. B. pp 125-36 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

Reactions of group IVA elements (except Th) with the other elements were studied. A classification of phase diagrams of Zr-base binary systems is proposed that includes four types of interaction: (i) continuous solid solutions of both modifications $\alpha$- and $\beta$-Zr, (ii) continuous $\beta$-Zr solid solutions at high temperature with breakdown to its monotectoid, eutectoid, or peritectoid with reduction in temperature, (iii) limited solid solutions on the basis of the $\alpha$ and $\beta$ modification of Zr and with eutectoid transformation of the $\beta$ solid solution, and (iv) limited solid solutions on the basis of the $\alpha$ and $\beta$ modification of Zr and with a peritectoid transformation of the $\beta$ solid solution. Brief consideration is given to the types of interaction of Hf with other elements. 39 ref. (Metals Abstr.)

**30064** INTERACTION OF HAFNIUM WITH SOME TRANSITION METALS AND ITS EFFECTS ON ALLOYING. Svechnikov, V. N.; Shurin, A. K.; Dmitrieva, G. P.; Alfintseva, R. A. pp 153-6 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

The interaction of Hf with a number of metals is reported in connection with the use of this material in making technically important alloys. There is almost no information on the effect of Hf on the properties of these metals. Phase diagrams are given for Hf with Fe, Mn, Co, and Ni over a whole range of concentrations. (Metals Abstr.)

**30065** THE ELECTRONIC THEORY OF ALLOYS BASED ON TITANIUM, ZIRCONIUM, AND HAFNIUM. Grigorovich, V. K. pp 156-7 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

An analysis of the binary phase diagrams of Ti, Zr, and Hf with alloying elements showed that closed packed hexagonal or cubic elements (Re, Co, Sc, etc.), as a rule, do not stabilize the solutions that are isostructural with them (those based on the $\alpha$-modification of Ti, Zr, or Hf) but the body centered cubic $\beta$-modification. The explanation of this is that during solution of these alloying elements in Ti, Zr, or Hf there is a change in the electronic structure of the dissolving element and a subsequent ionization or delocalization of the electrons of the not fully ionized atoms of the solute. The appearance of ions with $p^6$ or $d^6$ shells facilitates the occurrence of exchange bonding and stabilization of the bcc solid solutions. (Metals Abstr.)

**30066** EQUILIBRIUM DIAGRAMS OF METALLIDE SYSTEMS. Matveeva, N. M.; Kornilov, I. I.; Budberg, P. B. pp 157-64 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

The various types of reaction possible between metallides, e.g., continuous and limited solid solutions, ternary metallic compounds, and peritectic and eutectic mixtures, are illustrated in a short review of metallide systems. Some new experimental data are given for the metallide systems $Nb_3Al$–$Mo_3Al$, $TiCr_2$–$TaCr_2$, $NbCr_2$–$TaCr_2$, $TiCr_2$–$TaCr_2$–$NbCr_2$, and NiTi–FeTi, all of which form continuous solutions. The importance of the purity and homogeneity of the individual metallides is emphasized. Curves for transition to the superconducting state can be used as a measure of homogeneity. Several such examples are given for $V_2Zr$ and $Nb_3Al$ which differ in their degree of completion of formation reaction in binary systems. (Metals Abstr.)

**30067** RHENIUM PHASE DIAGRAM. Povarova, K. B.; Tylkina, M. A.; Savitskii, E. M. pp 170-8 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

A critical analysis is made of the phase diagram data of Re and suggestions made for further study based on theoretical and practical considerations. Re has a number of special properties which find wide use in several branches of technology although there is a deficiency of literature data on its physico-chemical properties. (Metals Abstr.)

**30068** BINARY SYSTEMS OF RHENIUM WITH RARE-EARTH METALS. Khamidov, O. Kh.; Savitskii, E. M. pp 178-85 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

A study was made of the physico-chemical reactions of Re with rare-earth metals. Re and rare-earth metals do not form wide regions of solubility in the solid state. A feature of the reactions in such systems is the formation of compounds $MRe_2$, where M is a rare-earth metal. Re forms compounds with a Laves type structure with all rare-earth metals except La, Ce, Eu, and Yb. The type of phase diagram and the formation of intermediate phases in binary Re–M systems apparently depends not only on the valency electrons but also on the number of the electrons in the inner shells and, in particular, the 4f electrons. 28 ref. (Metals Abstr.)

**30069** A STUDY OF THE PARTIAL PHASE DIAGRAM AND PHYSICAL PROPERTIES OF THE SEVEN-COMPONENT SYSTEM NIOBIUM–TUNGSTEN–MOLYBDENUM–TITANIUM–CHROMIUM–ZIRCONIUM–ALUMINIUM IN THE NIBOUM-RICH REGION. Pryakhina, L. I.; Ozhimkova, O. V. pp 58-60 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

A study was made of the seven component system Nb–W–Mo–Ti–Cr–Zr–Al to determine the phase composition and certain physico-chemical properties of Nb-base alloys and to study the compositions of heat resistant alloys of this system. A preliminary study was made of the Nb–W–Mo ternary system, i.e.,

from 100 to 60 wt % Nb, and of the four component system Nb–W–Mo–Ti in the Nb-rich region. From this work, an alloy composition, A, of optimum properties, was established in the four-component system that could be used for further alloying with Cr, Zr, and Al. The seven-component alloys were prepared by arc melting with 8 to 10 remeltings in He. From microstructural analyses and a study of the phase diagram the region for the extent of the seven-component Nb-base solid solutions in the quasi-quaternary A–Cr–Zr–Al system at 1200°C was provisionally established. Optimum compositions of those alloys with the greatest heat resistance and oxidation resistance at test temperature of 1000 to 1100°C were established. (Metals Abstr.)

**30070** PHASE DIAGRAMS OF RARE-EARTH METALS. Terekhova, V. F.; Savitskii, E. M.; Torchinova, R. S. pp 200-6 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

A short literature review of Soviet and foreign data on known rare-earth metal systems is given. Some new experimental data is introduced for phase diagrams of rare-earth metals with other elements, in particular, C, O, and H. The systems Sc–Al and Eu–Ni are considered in some detail and new experimental data given for the Sm–Gd and Sm–Ce systems. Some generalizations are made concerning the effect of 4f electrons on the nature of the interactions between rare-earth metals and other elements. (Metals Abstr.)

**30071** PHASE DIAGRAM AND STRUCTURE OF THORIUM–RHENIUM ALLOYS. Badaeva, T. A.; Dashevskaya, L. I. pp 212-18 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

The Th–Re diagram was constructed from an experimental study of the structure of Th–Re alloys by x-ray, microstructural, hardness, microhardness, and melting point determinations. As cast and sintered specimens were studied after quenching, preceded by long holding at temperature. The starting materials were compact Th (99.6%), powdered Th (99.5%), and powdered Re (99.8%). The compound ThRe, found previously, forms by a peritectic reaction and is in eutectic equilibrium with Th. The eutectic composition is 14.9 at. % Re at 1400°C. The compound $ThRe_2$ has no broadening region and there are no noticeable regions of solutions between Th and Re. (Metals Abstr.)

**30072** PHASE DIAGRAM OF THE RHENIUM–LANTHANUM SYSTEM. Badaeva, T. A.; Dashevskaya, L. I. pp 218-21 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

The Re–La system was studied using direct-arc-melted cast and sintered specimens by microstructural, hardness, microhardness, and x-ray methods. Re and La do not interact over the whole concentration range and form a region of immiscibility in the liquid and solid states. All the cast specimens showed separation into two liquid layers of Re and La. In sintering, the formation of the dispersed oxide $La_2O_3$ in the Re matrix occurs readily because of the high affinity of La for O and the absence of any reaction between La and Re. (Metals Abstr.)

**30073** REGULARITIES IN THE FORMATION OF SOLID SOLUTIONS OF METALS. Vozdvizhenskii, V. M. pp 231-41 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

The methods used in calculations for constructing phase diagrams are considered. A new volume factor is proposed that is calculated from the atomic diameter and atomic volumes of the components. Taken in conjunction with the temperature factor it provides a means of deducing the relationships that determine the possible formation of unlimited solid solutions and the occurrence of a minimum on the solidus curve. The conditions are shown that lead to the formation of eutectic or peritectic-type phase diagrams. An equation is derived for calculating the total limiting concentration of solid solutions in transition metals. 21 ref. (auth)

**30074** CONNECTION BETWEEN THE TEMPERATURE FACTOR AND THE CONSTRUCTION OF THE PHASE DIAGRAM OF BINARY SYSTEMS. Efimov, Yu. V. pp 247-57 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

The connection between the temperature factor $T_H/T_B$, ($T_H$ and $T_B$ are the lower and upper temperature respectively), i.e., the ratio of the absolute temperature of the formation of the equilibrium components, and the basic parameters (temperature and composition) of the particular points of a transformation of the $A \rightleftharpoons B + C$ type in binary systems was examined. A statistical analysis of about 600 actual systems and equilibria showed that for any transformation of this type there exists a favourable temperature factor. The laws for the formation of eutectics ($K_B + T_H/T_B = 1$) are general for any transformation of this type involving liquid or only solid phases. These relationships connect the temperature of the critical point of binodal curves of regions of monotectic and monotectoid coring with other parameters of these transformations. This relationship can be used with sufficient accuracy for checking the construction of phase diagrams from provisional data and for making more precise the different parameters and position of the particular points of transformations of the type $A \rightleftharpoons B + C$, and also for rationally selecting the composition and temperature of alloys for study. (auth)

**30075** GENERALIZATION FOR PHASE DIAGRAMS OF METALLIC SYSTEMS. Gulyaev, B. B. pp 257-67 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

A generalization for a number of different metals is made from existing phase diagrams of binary systems and forecasts made for a number of other systems which have not yet been studied or for which there is little data. This type of information may be used in predicting changes in parameters of binary diagrams for elements belonging to the next row of one Period or one Sub-Group of the Periodic Table and for assessing the parameters of systems with elements that have been little studied, i.e., by generalization from the parameters of better studied diagrams of neighbouring elements lying in the same Period or Sub-Group. (auth)

**30076** A GENERALIZED PHASE DIAGRAM FOR BINARY ALLOYS BASED ON COPPER, SILVER, AND GOLD. Gulyaev, B. B.; Dvoretskaya, G. F. pp 267-73 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

The solubility of various elements in Cu, Ag, and Au (probably in any other base-element also) and the type of phase diagram depends primarily on the position of the additive-element and of the base-element in the Periodic System. (auth)

**30077** STUDY OF QUATERNARY PHASE DIAGRAMS BY MICROHARDNESS. Zakharov, A. M. pp 280-9 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

A study was made of the theoretical premises involved in the use of the microhardness method for solving problems in studying quaternary phase diagrams, in constructing the boundary between different phase regions and the tie line in two phase regions. Using this method the main types of composition-microhardness diagram were constructed for quaternary $\alpha$ solid solution for various secondary sections: the method of constructing the tie line in the two phase regions of quaternary systems is described. The method is illustrated with the Nb–W–Mo–Zr system to show the construction of the boundaries of the quaternary $\alpha$–Nb solid solution. (auth)

**30078** CHEMICAL DIFFUSION IN THE SYSTEM IRON–MOLYBDENUM. Pivot, J. P.; Van Craeynest, A.; Calais, D. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Nucl. Mater., 31: 238-40(June 1969). (In French).

The method of determining diffusion in the system is described. Data are presented graphically in phase diagrams and diffusion curves. Micrographs of Fe–Mo diffusion zones are also included. (J.R.D.)

**30079** METAL–METAL CARBIDE EUTECTIC TEMPERATURES IN THE ALLOY SYSTEMS TUNGSTEN–RHENIUM, TUNGSTEN–MOLYBDENUM, AND MOLYBDENUM–RHENIUM. Fries, R. J.; Cummings, J. E.; Hoffman, C. G.; Daily, S. A. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 31: 230-2(June 1969).

The eutectic temperatures of W–30 at. % Mo, W–25 at. % Re, and Mo–26 at. % Re were determined in graphite-lined crucibles. Preparation methods for the specimens are described. (J.R.D.)

**30080** INTERNAL FRICTION OF NEPTUNIUM. Selle, J. E. (Mound Lab., Miamisburg, Ohio); Rechtien, J. J. Contract AT(33-1)-Gen-53. J. Nucl. Mater., 31: 203-10(June 1969).

The internal friction of neptunium has been measured from room temperature to 595°C in a low-frequency inverted-torsion pendulum. Particular attention was given to the phase transformations by analyzing the data for the modes of transformation. A large peak was observed in the beta phase for which tentative explanations are presented. (auth)

**30081** SOLUBILITY OF CARBON AND PRECIPITATION OF CARBIDES IN THE SOLID PHASE IN THE ALLOY U–1.5 PERCENT Mo. Giraud-Heraud, F. (Societe Industrielle de Combustible Nucleaire, Veurey-Voroize, France); Collot, C.;

Guillaume, C. J. Nucl. Mater., 31: 187-96(June 1969). (In French).

After a high-temperature anneal followed by a very rapid quench in uranium and uranium-molybdenum alloys, a fine oriented precipitation of UC is observed. A study of the gamma phase solvus line in the uranium/1.5% molybdenum/UC system and of the characteristics of the precipitation to identify the phenomenon as a continuous precipitation reaction is conducted with nucleation and epitaxial growth of the carbide in gamma phase. Microstructural features of the phenomenon, such as the formation of denuded zones around the primary carbides which were left undissolved during the anneal, or the refinement of the quenched structure of the gamma phase in the neighborhood of oriented carbide particles, are related to the rate of diffusion of carbon or to the nature of the alloys investigated. (tr-auth)

**30082** ANISOTROPY IN PLASTIC FLOW OF A Ti–8Al–1Mo–1V ALLOY. Feng, C.; Krull, W. E. (Lockheed-Georgia Co., Marietta, Ga.). Trans. Met. Soc. AIME, 245: 1101-9(May 1969).

A study was made of the development of texture and the anisotropy in plastic flow of Ti–8Al–1Mo–1V alloy. Based on pole figure determinations, the shifting of texture induced by rolling at approximately 400°C was found to be due primarily to slip rotation for the major portion of the material. Grain boundary shear is believed to be an important factor. The anisotropy of the textured alloy was examined in terms of the variation of yield stress under tension and the ratio of bi-axial strain increments $\mu_p$, in the temperature range 25 to 290°C. The results were related to Hill's theory on plastic anisotropy. The Schmid factors of $(1\bar{1}00)[11\bar{2}0]$, $(1\bar{1}01)[11\bar{2}0]$, and $(\bar{1}101)[11\bar{2}0]$ slip systems were analyzed and found to be compatible with the observed anisotropy. Cross slip between these planes was proposed as a possible deformation mode. (auth)

**30083** CLOSE-PACKED ORDERED $AB_3$ STRUCTURES IN TERNARY ALLOYS OF CERTAIN TRANSITION METALS. Sinha, Ashok K. (Univ. of Illinois, Urbana). Trans. Met. Soc. AIME, 245: 911-17(May 1969).

The quasi-binary systems "$VFe_3$"–$VCo_3$–$VNi_3$–"$VCu_3$" and "$TiFe_3$"–$TiCo_3$–$TiNi_3$–"$TiCu_3$" were studied by a combination of microscopic and x-ray methods. It is noted that there are no $AB_3$ phases in $VFe_3$, $VCu_3$, $TiFe_3$, and $TiCu_3$. Of the phases encountered, eleven had close-packed ordered layer structures. Within each system, there is an approximately linear variation of the degree of hexagonality of the stacking arrangement with electron concentration, e/a. A study of eighty-four known examples of $AB_3$ structures in transition metal alloys indicated that at e/a ≈ 8.65 the ordered structure of the close-packed layers changes from "triangular" ($AuCu_3$ type) to "rectangular" ($SbCu_3$ type). At e/a < 8.65, the slope of hexagonality vs e/a line increases with the group number of the A component. (auth)

**30084** CRYSTALLOGRAPHY OF THE ALPHA TO BETA TRANSFORMATION IN PLUTONIUM. Nelson, R. D.; Bowman, F. E. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Trans. Met. Soc. AIME, 245: 967-70(May 1969).

Evidence has been found for a $(010)_\alpha||(\bar{1}11)_\beta[10\bar{2}]_\alpha||[34\bar{1}]_\beta$ crystallographic relationship between the monoclinic $\alpha$ and $\beta$ phases of plutonium during the $\alpha \rightarrow \beta$ transformation. Results of x-ray diffraction studies, where [010] fiber textured $\alpha$ samples were used in the absence of suitable single crystals indicate that the $(010)_\alpha$ planes become $(\bar{1}11)_\beta$ planes upon transformation under near-equilibrium conditions. The transformation strain along the fiber axis, which was the [010] direction, was measured dilatometrically; the measured 8.5% expansion compares favorably with the 8.44% expansion in the interplanar spacing represented by the $(010)_\alpha||(\bar{1}11)_\beta$ relationship. From plots of the atom positions in each of the related planes, a correspondence was deduced between the $[10\bar{2}]_\alpha$ direction and the $[341]_\beta$ direction. Further analysis of the two lattice structures in the light of this relationship revealed a rotation about the $[10\bar{2}]_\alpha$ direction of 1° 43 min and a slight shearing in this same direction of about 30 min. (auth)

**30085** EFFECT OF $ThO_2$ PARTICLES ON GRAIN GROWTH AND PREFERRED ORIENTATION IN TUNGSTEN SHEET. Walter, J. L.; Seybolt, A. U. (General Electric Research and Development Center, Schenectady, N. Y.). Trans. Met. Soc. AIME, 245: 1093-99(May 1969).

The effects of the addition of 0.5% $ThO_2$ (by volume) on the grain structure and texture of heavily rolled tungsten sheet were studied. Powder metallurgy ingots were rolled to sheet, 0.001 in. thick, and samples were annealed at temperatures from 1200 to 2500°C. The heating rate to the anneal temperature was varied from 3 to 6500°C per min. The orientations of the largest grains were determined by x-ray diffraction. The disposition and loss of the $ThO_2$ particles were determined by electron transmission microscopy and the activation energy for removal of the thorium was measured by mass spectroscopy. Heating rates below about 800°C per min produced large, highly elongated grains. Higher heating rates produced much smaller, less elongated grains. The grain structure and texture of the slowly heated samples were identical to the structures and textures of heavily rolled tungsten foil conventionally doped with aluminum, silicon, and potassium but the recrystallization temperature was about 200°C lower. There was stringer-like dispersion of larger $ThO_2$ particles superimposed on a uniform dispersion of fine particles. The particles increased in size and decreased in number with time at temperature. The loss of particles was accompanied by formation of grain boundary voids and surface pits. The activation energy for removal of the $ThO_2$ was about 40 kcal per mole. (auth)

**30086** ELECTRON MICROAUTORADIOGRAPHY AND ITS APPLICATIONS. Tiner, N. A.; Asunmaa, S. K. (Douglas Aircraft Co., Newport Beach, Calif.). Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 187-95(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

Electron microautoradiography is a method of determining the amount and distribution of trace elements in a sample by utilizing the nuclear properties of radioactive isotopes and the high resolution of electron micrographs. Radio-isotopes are either introduced into the sample by a chemical process or the sample is irradiated by placing it in an intense flux of neutrons to produce a measurable amount of a radioisotope of the element to be determined. The radioactive isotope emits gamma or beta rays. Its location as well as its amount is recorded by a two layer film of carbon replica and nuclear track emulsion, and the film is examined in the electron microscope. Methods of preparing electron microautoradiographs and their use in solving various materials problems are described. (auth)

**30087** A NOTE ON THE METALLOGRAPHY OF NEPTUNIUM. Richter, A. E. (Dow Chemical Co., Golden, Colo.). Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 179-80(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

A technique to reveal the microstructure of neptunium is described. As-cast, as-extruded, and as-rolled microstructures of the metal are shown. (auth)

**30088** TELEVISED TRANSFORMATIONS OF PLUTONIUM. Arrowsmith, H. W. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 9-15(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

A detailed study of the $\alpha \rightarrow \beta$ and $\beta \rightarrow \alpha$ transformations in plutonium was performed using a metallograph and a high resolution television system. A new hot stage using an oil filled evacuated chamber was developed to permit the long-term observation of the alpha, beta, and gamma phases of plutonium at 120 to 260°C with a temperature control of ±0.5°C. The new generation of television cameras, recorders, and monitors made it possible to use them with standard metallographic equipment to obtain film quality records of dynamic events. A distinct difference between the $\alpha \rightarrow \beta$ and $\beta \rightarrow \alpha$ transformations has been found in using the advanced hot stage and the high resolution television system. (auth)

**30089** PHASE IDENTIFICATION IN MODIFIED Cb 132 ALLOYS. Chesnutt, J. C.; Faunce, C. A.; Geary, A. R.; Peacock, D. E. (Pratt and Whitney Aircraft, Middletown, Conn.). Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 79-92(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

An investigation was made of the carbide precipitates in three modifications of the niobium base alloy Cb 132. The chemical compositions of the modifications are as follows: Cb 132M1 Nb-20 wt % Ta-15 wt % W-5 wt % Mo-1 wt % Zr-0.13 wt % C, Cb 132M2 Nb-20 wt % Ta-15 wt % W-5 wt % Mo-2 wt % Zr-0.26 wt % C, Cb 132M3 Nb-20 wt % Ta-15 wt % W-5 wt % Mo-2 wt % Hf-0.13 wt % C. The multiphase metallographic structure of these alloys varies considerably with thermal and mechanical treatment and the purpose of the investigation was to determine to what extent the nature as well as the morphology of the precipitates could be established by metallographic means. To this end, a previously developed technique of anodic stain etching was applied and the results correlated with those obtained with conventional etching techniques and a previous x-ray diffraction study of the precipitates after extraction from the matrix. The x-ray

diffraction study revealed the presence of three different carbides. In samples of Cb 132M2 quenched from temperatures up to 2200°C the only carbide produced is an MC type. In Cb 132M1 and Cb 132M3 samples quenched from temperatures below 1900°C both MC and $M_3C$ type carbides are found while in samples quenched from above 1900°C an additional phase is produced. This high-temperature phase (H.T.P.) has been tentatively identified as having an hexagonal structure with a c/a ratio of 4.36. Results indicate that anodic stain etching can be used to reveal the presence of these different carbides but that it is not always possible to interpret the results unambiguously. For example, samples of Cb 132M2 and Cb 132M1 quenched from above 1900°C both contain a platelike precipitate and the color difference as a result of anodization allows differentiation between the MC plates in the Cb 132M2 and the H.T.P. plates in the Cb 132M1 alloy. However, in a sample of Cb 132M1 quenched from 1900°C it is not possible to distinguish between plates of H.T.P. and $M_3C$ since both these non-cubic phases tend to stain similarly. Anodic stain etching was also applied to a Nb-1.4 wt % C alloy and a Nb-5 wt % Zr-0.13 wt % C alloy and the results obtained correlated with those found for the more complex materials. (auth)

**30090** QUANTITATIVE METALLOGRAPHY OF DISPERSION-STRENGTHENED ALLOYS FROM EXTRACTION REPLICAS: VOLUME FRACTION AND INTERPARTIAL SPACING. McCall, J. L.; Body, J. E. (Battelle Memorial Inst., Columbus, Ohio). Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 153-5 (1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

The beneficial mechanical properties of dispersion-strengthened alloys depend largely on the number, size, and spacing of the dispersoid particles. Several experimental methods for evaluating these characteristics of the particles have been developed; however, in general, these methods are either qualitative, lack resolution for the smaller particles, or, if quantitative, too time-consuming to be practical for most applications. Research performed using the technique of extraction replication for determining both volume fraction and interparticle spacing of dispersoid particles is described. The research included comparisons of the distribution of extracted particles with distributions of the particles determined by area analysis and complete dissolution analysis. A method for determining the volume fraction of dispersoid particles was developed using the extraction technique which involves only counting the total number of particles in a unit area of the replica, and measuring the size of the mean and maximum size particle. The interparticle spacing can be determined even more simply by counting the number of particles on an area of the replica and measuring the largest particle. These methods have been used on several alloy systems to verify their validity. (auth)

**30091** SAMPLE PREPARATION FOR SCANNING ELECTRON MICROSCOPE METALLOGRAPHY. Johari, O.; Corvin, I.; Dragen, R. F. (Illinois Inst. of Tech., Chicago). Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 127-31(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

Highly polished sections are required for quality metallography using conventional optical techniques. This is especially true at high magnifications, around 2000×, where the resolution of the optical microscope is only about 2500 Å and the depth of focus is so small that the presence of scratches or some other roughness on the surface of a specimen will affect the quality of the micrograph. The scanning electron microscope, with its large depth of focus, satisfactory resolution (250 Å), range of available magnifications (45× to 30,000×), and the ease of direct examination offers a unique tool for excellence in metallography. Results of metallography on polished and unpolished surfaces of a Ti-8% Mo alloy are reported. The results are interpreted in terms of possibilities for scanning electron microscope metallography. (auth)

**30092** METALLOGRAPH FOR GLOVE BOX OPERATIONS. Gray, R. J.; Leslie, B. C. (Oak Ridge National Lab., Tenn.). Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 119-25(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

Metallographic examinations of alpha radioactive, toxic, hygroscopic, pyrophoric, or other reactive materials often require a metallograph confined in a glove box. A Bausch and Lomb Research I metallograph was modified to meet these requirements. Illumination, visual examination and photomicrography are accomplished through the use of optical relays, which are sealed lens systems that transfer the image with a minimum change in magnification, resolution or aberration. The lenses are sealed in place to help maintain the integrity of the box for the required negative pressure and atmosphere. Focussing for photomicrography is accomplished with a step-motor. The performance of this instrument in all aspects of microscopy has been essentially unchanged after the modification. (auth)

**30093** AUTORADIOGRAPHIC STUDY OF $^{14}C$ IN HASTELLOY N. Gehlbach, R. E. (Oak Ridge National Lab., Tenn.); Allen, M. D.; Braun, J. D. Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 113-18(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

Carbon distribution in Hastelloy N was studied using autoradiographic techniques. The radioisotope $^{14}C$ was introduced into the molten alloy and the resulting distribution and microsegregation of carbon in and around precipitates were followed as a function of heat treatment. Autoradiographic emulsions discussed include stripping film and NTD-2, NTD-3, and NTE liquid emulsions made by Kodak. Methods of liquid emulsion application, precautions with the emulsions, sample preparation, sources of errors, artifacts, and interpretation are discussed. Carbide and noncarbide phases are easily distinguished by autoradiographic techniques. Supplementary techniques are discussed which permit thorough identification of phases present. A high-temperature noncarbide phase is shown to be involved in the transformation from pseudo $M_6C$ carbides to an intermetallic silicide phase. (auth)

**30094** MELTING EQUILIBRIA OF THE SYSTEM URANIUM–$UAl_2$–$Al_8Mo_3$–MOLYBDENUM. Petzow, Guenter; Rexer, Juergen (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 60: 449-53(May 1969). (In German).

The liquidus faces of primary solidification and the nonvariant melting equilibria of the system uranium $UAl_2$-$Al_8Mo_3$-molybdenum have been established by thermal, microscopic and x-ray analysis. A ternary Laves phase of the C 14 type ($U(Al, Mo)_2$) was found. This phase reacts with the binary phases $UAl_2$ and $AlMo_3$ giving two nonvariant three phase equilibria. The two high-temperature phases in the binary system molybdenum-$Al_8Mo_3$ cannot be stabilized by adding uranium. In total, eight four-phase melting reactions have been established, seven of which are transition equilibria and one of which is eutectic. (auth)

**30095** DISSOCIATION PRESSURE OF BISMUTH IN THE SYSTEM BISMUTH–THORIUM. Dahlke, Olaf; Gans, Wigbert; Knacke, Ottmar; Mueller, Franz (Technische Hochschule, Aachen. Kernforschungsanlage, Juelich, Ger.). Z. Metallk., 60: 465-8(May 1969). (In German).

The dissociation pressure of bismuth in the system bismuth-thorium was determined using the effusion method due Knudsen between 600 and 1400°C. Isothermal dissociation curves and x-ray diagrams corroborated the compounds $ThBi_2$ and $Th_3Bi_4$ which do not form solid solutions. For ThBi a narrow range of homogeneity between $ThBi_{1.08}$ and $ThBi_{0.8}$ is indicated. The supposed compound $Th_2Bi$ was not found using measurements of the partial pressure. The values of log ($p_{Bi} + p_{Bi_2}$) were given for the vapor pressure and for the pressure of dissociation of bismuth in the univariant equilibria. (auth)

**30096** ON THE CONSTITUTION OF COPPER-RICH COPPER–BERYLLIUM–COBALT ALLOYS. Reinbach, Rudolf; Baer, Hans Guenter (Laboratorium der Vacuumschmelze GmbH, Hanau, Ger.). Z. Metallk., 60: 453-6(May 1969). (In German).

The behavior of copper-rich alloys containing both beryllium and cobalt as alloying additions is clarified for the temperature range between solidification and 400°C by means of structural and microstructural investigations as well as by microprobe analyses. The range of existence of the copper-rich solid solution at 800°C is determined with the aid of measurements of the lattice constants. Qualitative information is given on the constitution of the quasi-binary section CuBe–CoBe and the partial triangle copper-CuBe–CoBe. (auth)

**30097** STRUCTURAL ASPECTS OF FATIGUE IN BERYLLIUM SINGLE CRYSTALS. Breedis, J. F. (Massachusetts Inst. of Tech., Cambridge); Lawley, A. Metal Sci. J., 3: 81-7 (May 1969).

Surface detail and the underlying dislocation substructures were examined in single crystals of beryllium after bend fatigue at room temperature. Crystals were oriented for preferential slip on the basal plane or on a $\{10\bar{1}0\}$ prism plane. A persistent slip structure, in the form of closely spaced pits, existed below the bend surface, the depth of penetration depending upon the stress level. Discoloration of the bend surface accompanied duplex slip in crystals oriented for prism slip. Dislocation loops constituted the most common form of the fatigue substructure. The loops were classi-

fied as: long loops ≥1000 Å in length elongated in ⟨10$\bar{1}$0⟩ directions; elongated loops formed from the longer loops by a "pinching-off" process; small loops of approximately circular shape having dia down to ~70 Å. This form of substructure was compared with that resulting from tensile loading. Diffraction contrast effects indicated that for the elongated loops the loop vector was of the form $\frac{1}{3}$⟨$\bar{2}$110⟩ and that the loop plane could rotate. The loop plane and vector of the small circular loops were not unambiguously determined. Recovery of the bend-fatigue substructure could be promoted in thin foils by prolonged exposure in the electron microscope at high beam intensities. However, in bulk fatigued crystals, temperatures of ~300°C were required for dislocation rearrangements. (auth) (UK)

**30098** THE SUBSTRUCTURE OF $Ni_3Mo$ DUE TO ORDERING. Ruedl, E. (CCR–EURATOM, Ispra, Italy); Amelinckx, S. Mater. Res. Bull., 4: 361-8(June 1969).

The substructure of $Ni_3Mo$ resulting from ordering consists of anti-phase boundaries and twins. The quenched-in fcc phase exhibits short range order of the same type as in $Ni_4Mo$. The short range order can be destroyed by irradiation. The transition from the fcc stacking to the ordered pseudo-hexagonal stacking (orthorhombic) is presumably a shear transformation as can be deduced from the orientation relationship. The stacking fault energy is small in the fcc + NiMo phase, as can be concluded from the presence of large extended nodes. (auth)

### *Radiation Effects*

*Refer also to abstract 30880.*

**30099** (GEMP–1010, pp 45-98) RADIATION EFFECTS ON FAST REACTOR CLADDING AND STRUCTURAL MATERIALS (1304). Moteff, J.; Kingsbury, F.; Smith, J. P. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.).

Post-irradiation creep-rupture tests at 705°C on Hastelloy X show that for the stress range investigated ($\sigma < \sigma_{ys}$) minimum creep rate and time to rupture are reduced by irradiation. The $\sigma$ versus $\dot{\epsilon}$ irradiated and control curves converge at a stress equivalent to yield stress; the $\sigma$ versus $t_R$ curves are nearly parallel. Post-irradiation creep-rupture tests at 760°C on Inconel 625 show that minimum creep rate is slightly increased by irradiation, whereas time to rupture is reduced by a factor of approximately 20 compared to the unirradiated control specimens. Elongation at rupture is reduced from unirradiated values of 20 to 30 percent to post-irradiation values of 1 to 2 percent. The low-cycle fatigue life of Type 316 stainless steel is reduced by a factor of approximately 2.5 at 650°C ($\dot{\epsilon} = 4 \times 10^{-5}$ sec$^{-1}$) by irradiation of $4.8 \times 10^{18}$ n/cm$^2$ ($E_n \geq 1$ MeV). For the same test conditions, fatigue life of Type 304 stainless steel following irradiation to $6.3 \times 10^{18}$ is reduced by a factor of 2. A detailed resistivity study was completed, based on isothermal and isochronal anneals in the 0.31 $T_m$ temperature region of tungsten after fast-neutron irradiation ($E_n \geq 1$ MeV) at about 70°C over a fluence range of $5.9 \times 10^{18}$ to $1.5 \times 10^{21}$ n/cm$^2$. Hot-microhardness data were determined for unirradiated and irradiated vanadium and VANSTAR-9. Transmission electron microscopy studies of molybdenum irradiated to neutron fluences of $1.4 \times 10^{20}$ n/cm$^2$ and $1.5 \times 10^{21}$ n/cm$^2$ ($E_n \geq 1$ MeV) at 70°C revealed anomalous behavior. The lower-fluence specimen exhibits a greater cluster concentration than the higher-fluence specimen. Preliminary transmission electron microscopy indicates that the density of clusters in irradiated vanadium alloys, V-20Ti and VANSTAR-9, are more numerous than in pure vanadium single-crystal material irradiated under similar conditions. Neutron spectra were calculated for various positions in EBR-II rows 2 and 7 using the Monte Carlo method. These spectra were used to spectrum correct the (n,p) cross sections of $^{58}$Ni, $^{54}$Fe, and $^{46}$Ti. The spectrum-corrected cross sections and experimentally determined specific activities permitted accurate fast-flux ($E_n \geq 1$ MeV) mapping of EBR-II rows 2 and 7. The flux maps were completed and the spectrum-corrected cross sections permit accurate calculation of fast fluxes ($E_n \geq 1$ MeV) at any position in rows 2 and 7. (auth)

**30100** IRRADIATION OF SLIGHTLY ALLOYED URANIUM FUEL ELEMENTS IN THE EL-3 REACTOR. Allain, C.; Aubert, H.; Laniesse, J. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). J. Nucl. Mater., 31: 162-86(June 1969). (In French).

Fuel elements have been made by industrial methods from 2 uranium alloys containing Al, Fe, Si, Cr (Sicral F1 and F2) and from 3 uranium alloys containing Cr, Mo, Fe and Si (U–Cr 0,1%; U–Mo–Cr–Fe and U–Si–Cr) in various proportions. Information is presented about the structure, mechanical strength, creep resistance, and pre-irradiation thermal conductivity of these fuel elements. The five alloys were each irradiated to two different neutron doses in the range 1300 to 4200 MWd/tonne. The irradiation temperature was 250°C at the tube surface and reached a maximum of 630°C at the internal interface. During irradiation, the thermal conductivity of one of the alloys decreased by 35% at a dose of 5000 MWd/tonne; the density also decreased and the appearance of a porous ring at temperatures slightly below 500°C was noted. Substantial differences in the change of density consequence on irradiation were found between the five alloys, Sicral $F_1$ responding well, uranium–chromium poorly. The possible explanations for these differences are discussed. Mechanical strength and creep resistance do not have an important role in this connection. (tr-auth)

**30101** THERMAL ACTIVATION OF SLIP IN PRESTRAINED NEUTRON-IRRADIATED IRON BY FLOW STRESS AND STRESS RELAXATION MEASUREMENTS. Soo, Peter (Brookhaven National Lab., Upton, N. Y.). Trans. Met. Soc. AIME, 245: 985-90(May 1969).

Prestrained Ferrovac E iron has been neutron-irradiated at approximately 90°C to an integrated flux of $10^{20}$ nvt (E > 0.82 MeV). The irradiation was found to produce an increased temperature dependence of the flow stress in addition to a greatly increased athermal stress. Measurements of the flow stress and stress relaxation, from which the activation volume and activation energy for slip were deduced, show that neutron irradiation changes the rate-controlling slip process to one based on dislocation interactions with tetragonal distortions which are produced around submicroscopic interstitial loops in the lattice. The study indicates that without prestraining prior to irradiation the chances of detecting a change in the rate-controlling slip process are greatly reduced because in the initial stages of slip a substantial fraction of the radiation defects are swept out of the slip plane by gliding dislocations. Thus, activation parameters which are subsequently measured are representative of a greatly reduced defect density and would not differ appreciably from those for unirradiated material. The large increase in the athermal component of the flow stress is probably connected with the presence of depleted zones in the lattice which are introduced by irradiation. (auth)

**30102** OBSERVATION OF DAMAGE SHELLS IN IRRADIATED METALS. Rau, Robert C.; Ladd, Robert L. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 169-72(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

Transmission electron microscopy was used to study the microstructural effects of thermal neutron transmutation of segregated boron in A-286 and Hastelloy R-235 alloys, and in vanadium. These observations show the presence of shells of enhanced radiation damage surrounding boron-containing precipitates in these metals. The shells, which initially consist of defect clusters resulting from atom displacement cascades, are duplex in nature, having an inner damage region caused by recoiling lithium ions and an outer damage region caused by recoiling alpha particles. Post-irradiation annealing leads to the elimination of the defect clusters and replaces them with dislocations and gas bubbles. (auth)

## Ceramics and Cermets

*Refer also to abstracts 29051, 29952, 29955, and 29957.*

**30103** CONTINUOUS COMPILATION OF NEW REFERENCE DATA ON DIFFUSION PROCESSES IN INORGANIC SOLIDS AND THEIR MELTS. Diffus. Data, 3: No. 1, 1-118(Apr. 1969).

Temperature and pressure ranges of new data on diffusion processes in inorganic solids and their melts are summarized. Experimental methods used for determining the purity and properties of materials are given. Diffusion coefficients, isotope effects, thermal diffusion, thermotransport, electrotransport, and electrolytic diffusion, permeation of gases, are discussed. (J.C.W.)

### *Corrosion and Erosion*

*Refer also to abstract 30139.*

**30104** STABILITY OF GAS BUBBLES IN AN IRRADIATION ENVIRONMENT. Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 31: 153-61 (June 1969).

The dynamic re-solution of small gas bubbles in $UO_2$ is discussed in some detail, both for conditions when the dissolved gas can and those when it cannot diffuse back into the bubbles. In accord with experimental observations, the model predicts

that the bubble nucleation density is virtually independent of both the irradiation temperature and the fission rate. Further, the model enables the fraction of gas in dynamic solution and the fraction of gas contained within bubbles to be calculated for different values of gas atom diffusion coefficient. In practical cases, below about 1000°C, irradiation-enhanced diffusion dominates thermal diffusion and results in the precipitation of some 50% of the gas. At temperatures above 1000°C, where thermal diffusion predominates, the fraction of gas in bubbles steadily increases with increase in temperature. (auth)

**30105** OXIDATION OF METALS CONTAINING DISPERSED OXIDE PARTICLES. Rapp, Robert A. (Ohio State Univ., Columbus). Met. Soc. Conf., 47: 539-62(1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

A review of the isothermal oxidation kinetics, scale morphologies, and scale adherence for the oxidation of metals containing dispersed oxide particles is presented. Both small, equiaxed dispersed oxide particles (inert and reactive) and larger lamellar particles are considered in combination with matrix metals which form scale principally at the oxide/gas interface, as well as metals which form scale at the metal-scale interface. Selected pertinent investigations from binary alloy oxidation have been chosen for discussion to complement the rather limited observations available for the oxidation of dispersion strengthened metals. Although the oxidation behavior of TD nickel and similar dispersion strengthened metals differs little from that of the matrix metal, other types of metal/particle combinations can result in significantly different oxidation behavior. Further experiments are needed to substantiate the proposed models and their influence on the oxidation behavior. (auth)

## Preparation and Fabrication

*Refer also to abstracts 29038, 29040, 29090, 29992, 30155, and 30190.*

**30106** (IA-1155) PREPARATION OF SELF-SUPPORTED TANTALUM OXIDE FILMS. Aladjem, A. (Israel Atomic Energy Commission, Tel Aviv). Dec. 1968. 5p. Dep.

A technique was developed for producing self-supporting tantalum oxide films of either natural oxygen isotopic composition or labeled with specific O isotopes. The technique is based on anodizing and subsequent electrolytic dissolution of the base metal. Films up to 6 mm in diameter and 60 to 3000 Angstrom thick are now in limited-scale production. The films show low permeability to radon and a fairly high mechanical strength. The possible uses of the films are mainly as covers for radioactive sources or in nuclear instrumentation, but a more accurate evaluation must await completion of radiation damage tests which are in progress. Other possible uses are being investigated. (auth)

**30107** (N-69-21404) FABRICATION OF CERMETS OF URANIUM NITRIDE AND TUNGSTEN OR MOLYBDENUM FROM MIXED POWDERS AND FROM COATED PARTICLES. Takkunen, Philip D. (National Aeronautics and Space Administration, Cleveland, Ohio, Lewis Research Center). Apr. 1969. 35p. (NASA-TN-D-5136). CFSTI.

Cermets containing uranium nitride particles dispersed in a matrix of tungsten or molybdenum were fabricated by cold-pressing and sintering mixed powders and by hot isostatic compaction of metal-coated UN particles. The effects of powder particle size and sintering conditions (time, temperature, and atmosphere) on the microstructure and density of cermets containing 50 volume percent UN were studied. Some sintered cermets were further densified by hot pneumatic impaction. Spherical UN particles coated with W or Mo were consolidated by hot isostatic compaction to produce dense cermets containing from 50 to 70 volume percent UN. (auth) (STAR)

**30108** (ORNL-TM-1780) PREPARATION OF POROUS THORIA BY INCORPORATION OF CARBON IN SOLS. Notz, K. J. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 59p. Dep. CFSTI.

Porous thoria with a wide range of controlled porosity was prepared by a sol-gel technique. Carbon was incorporated in thoria sols to produce stable mixed sols, which were gelled as either shards or microspheres. Subsequent removal of the carbon by combustion in air under appropriate conditions yielded thoria with porosities ranging from less than 1 to 72%. The two major variables affecting porosity are the $C/ThO_2$ mole ratio and the firing schedule. When the thoria matrix is first set by sintering at a high temperature and the carbon is then burned out at a lower temperature, the resultant porosity is approximately equal to the calculated volume of the removed carbon. After carbon removal, subsequent exposure to high temperatures sinters out much of the introduced porosity. In some cases, pore size distributions over narrow ranges are obtained in the submicron range. The pore size varies with both the carbon content and with the firing procedure; it can also be altered by using different sources of carbon. Surface area and density data, in conjunction with porosity values, were used to construct a realistic interpretation of the gelation and the sintering mechanisms. The kinetics of carbon burnout was studied, and an activation energy of 41 kcal/mole was determined for burning in air at 440 to 500°C. Carbon removal with steam, $CO_2$, and hydrogen was examined briefly. Porous $(Th,U)O_2$ was also prepared by the same method used for porous $ThO_2$. (auth)

**30109** (STI/PUB-207) SOL-GEL PROCESSES FOR CERAMIC NUCLEAR FUELS. Panel Proceedings Series. Proceedings of a Panel held in Vienna, 6-10 May 1968. (International Atomic Energy Agency, Vienna (Austria)). 1968. 186p. (CONF-680532). IAEA: $5.00; Austrian Schillings 130,-; £2.1.8; F. Fr. 24,50; DM 20,-.

A separate abstract was prepared for each of the seventeen papers presented at the panel meeting. (J.R.D.)

*For abstracts of individual papers see: 30121, 30123-30133, 30161, 30162, 30187, 30188, and 30192.*

**30110** (WAPD-TM-789) PLANETARY BALL MILLING AS A METHOD OF COMMINUTING PRESINTERED THORIA-URANIA GRANULES (LWBR DEVELOPMENT PROGRAM). Burke, T. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1969. Contract AT(11-1)-Gen-14. 26p. Dep. CFSTI.

Planetary ball milling was investigated as a method of comminuting presintered thoria ($ThO_2$)-urania ($U^EO_2$) granules for the preparation of sinterable feed powders. The experimental results indicated that planetary ball milling offers significant size-reduction rate advantage over conventional wet ball milling. $ThO_2$ + 5.1 and 7.9 wt% $U^EO_2$ powders, with a sinterability equivalent to that of powders conventionally wet ball milled for 44 hours, were produced by wet planetary ball milling for 4 hours. Although planetary ball milling offers a distinct advantage in milling time of $ThO_2$-$U^EO_2$ powders over that of conventional wet ball milling, it contaminates the powders with iron to a level that requires acid leaching of the powders to assure an acceptable iron content in the sintered pellets. (auth)

**30111** RADIATION SHIELDING MATERIAL AND METHOD OF MAKING SAME. Tashlick, Irving; Rosensweig, Alan. U. S. Patent 3,437,602. Apr. 8, 1969. Filed Nov. 25, 1966.

An improved radiation shielding structural material is described. A homogeneous mixture containing a major proportion of a finely divided particulate high density metallic ore and a minor proportion of a solid organic thermoset resin, which is the product of a quick cured low viscosity thermosetting liquid containing a curable polyester resin and styrene, is used. (Offic. Gaz.)

**30112** TD NICKEL AND TD NiC FOR TURBINE VANE APPLICATIONS. Godfrey, L.; Hauser, H. A.; Berkley, S. G.; Bradley, E. F. (United Aircraft Corp., East Hartford, Conn.). Met. Soc. Conf., 47: 885-905(1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

Joining methods for TD Nickel ($Ni-2ThO_2$) and TD NiC ($Ni-20Cr-2ThO_2$) are discussed with emphasis on the construction of gas turbine nozzle guide vanes. Methods include TIG welding, resistance welding, brazing, resistance brazing and resistance diffusion bonding. Metallurgical and mechanical characteristics of joints are described and related to engine test behavior. For TD Nickel, resistance brazing is the most satisfactory method for joining the trailing edge of sheet metal vanes. In contrast, conventional resistance welding is adequate for TD NiC joints. TD Nickel can be brazed satisfactorily with 60 Pd-40Ni-Li + B and Ni-Si-B alloys but the latter is preferred. The susceptibility of TD Nickel to sulfur attack in a gas turbine engine environment is illustrated and compared with laboratory exposures in sulfur-rich atmospheres. The use of a Cr-Al coating or TD NiC prevents sulfur attack. (auth)

**30113** DISPERSION-HARDENED ALLOYS MADE BY VAPOR PLATING AND CHEMICAL PRECIPITATION TECHNIQUES. Gimpl, M. L.; Fuschillo, N. (Melpar, Inc., Falls Church, Va.). Met. Soc. Conf., 47: 719-40(1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

Methods of producing dispersion hardened alloys such as vapor

plating in a fluidized bed, and chemical precipitation in a suspension of oxide particles were investigated. Gold, platinum, and copper alloys produced by the second method have been tested. Mechanical property tests show strength to be very sensitive to gas content of the alloys. Fully degassed alloys show tensile strengths much higher than the elemental materials. Electrical resistivities of the dispersion hardened materials are increased by less than five percent over that of the pure elements. Thoria was shown to be the dispersoid of choice because of its greater stability at temperatures above 900°C. (auth)

**30114** ELECTRODEPOSITION OF DISPERSION-STRENGTHENED ALLOYS. Dunkerley, F. J. (Univ. of North Carolina, Charlotte); Leavenworth, H. W.; Eichelman, G. E. Met. Soc. Conf., 47: 695-718(1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

Dispersion-strengthened nickel base alloys are being developed by an electrodeposition technique which involves simultaneous deposition of nickel and submicron-size oxide powders. Methods which were evaluated as an integral part of the electrodeposition process included: electrophoresis, mechanical and/or bubble agitation, constant and intermittent superimposed potential, current reversal, and ultrasonic vibration. These methods were employed using submicron-size particles in several different nickel plating baths. The mechanism by which submicroscopic oxide particles and nickel were co-deposited involves particle deposition which is primarily effected by mechanical occlusion. While submicroscopic particles of appropriately selected and processed oxides can be distributed throughout the nickel matrix by all the methods evaluated, inclusion of ultrasonic vibration into the nickel-dispersoid plating process was most effective for obtaining a uniform particle distribution. Particle size, shape, and distribution in the nickel matrix as revealed by electron micrographs and corresponding high and ambient temperature mechanical property data are presented to show the effect of uniform particle dispersion. No significant improvement in tensile strength above that of unalloyed nickel was obtained by a critical dispersion of submicron size powders in electrodeposited nickel until thermo-mechanical treatments were used to strengthen the deposits indicating that the presence of particles themselves is not sufficient for high temperature strengthening. (auth)

**30115** MANUFACTURING TECHNIQUES FOR OXIDE DISPERSION-STRENGTHENED ALLOYS. Triffleman, Bernard (Curtiss-Wright Corp., Buffalo). Met. Soc. Conf., 47: 675-94 (1968).

From Second Bolton Landing Cnference, Bolton landing, N. Y. See CONF-660626.

A chemical reduction process for the manufacture of oxide dispersed phase strengthened prealloyed powders was described. This process is capable of producing a fully alloyed matrix of chromium-bearing cobalt and nickel base materials with in situ formation of the oxide dispersed phase in fine particulate form. The elevated temperature properties of these materials are dependent not only on the characteristics of the powder, but also on the subsequent consolidation procedures. While this work is in the early stages of development, it is felt that sufficient promise has been shown to warrant a high level of confidence in the future of these materials. Much additional work will be required to optimize the process in all stages of manufacture. (auth)

**30116** OXIDE-STRENGTHENED ALLOYS BY THE SELECTIVE REDUCTION OF SPRAY-DRIED MIXTURES. Cheney, R. F.; Smith, J. S. (Sylvania Electric Products Inc., Towanda, Pa.). Met. Soc. Conf., 47: 637-74(1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

Oxide-dispersion-strengthened matrices of Ni–15Mo, Ni–20Cr, Co–15Mo, and Co–20Cr–11Ni–8Mo have been made from powders which were prepared by the selective-reduction of mixed oxides. Data and discussion are presented for the Ni–15Mo–4$ThO_2$ system. An almost molecular mixture of the oxides is obtained by drying an atomized solution of all the alloy components and then converting the dried metal salts to oxides by firing them in air. Reduced powders have been prepared which contain well dispersed $ThO_2$ particles. By controlling process temperatures, the average diameter of the $ThO_2$ particles can be varied between 100 and 500Å. The alloy powders can be consolidated by hydrogen sintering, powder rolling, and extrusion. The smaller $ThO_2$ sizes tend to grow larger during consolidation at temperatures >900°C. Conditions have been investigated for processing the consolidated powders to wrought rod and sheet. Good strengths have been obtained at 980°C and above and have been found to be dependent on the deformation-anneal history, as well as on the efficiency of the dispersion. The elements in solid solution provide strengths at intermediate and lower temperatures comparable to the strengths of the alloys without the dispersion. (auth)

**30117** JOINING OF THORIA DISPERSION-STRENGTHENED NICKEL-BASE ALLOYS. Yount, R. E. (General Electric Co., Evendale, Ohio). Met. Soc. Conf., 47: 845-83(1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

The results of investigations of processes applicable to joining dispersion strengthened nickel and nickel-chromium are presented. Development has been directed toward those joining techniques which cause the least disturbance of the thoria dispersion. Since fusion processes cause an agglomeration and/or slagging off of the thoria resulting in a drastic loss in strength at high temperature, processes investigated have for the most part avoided melting of the base metal. Diffusion bonding, both creep and yield strength limited processes, has had extensive investigation. One unique diffusion bonding process has been developed using a conventional resistance welding machine to effect a diffusion bond by controlling the heat input, electrode pressure, and heat cycles. Vacuum hot pressing has also been used to produce diffusion bonds. High temperature brazing has also been extensively evaluated. Development of a family of brazing alloys which provides usable joint strength to 2200°F under proper conditions of overlap, gap and brazing conditions is reported. Brazing using a tungsten inert gas welding torch has also provided satisfactory joints for certain applications. Two fusion processes, flash welding and resistance spot welding, have been examined and high temperature joint efficiencies measured. Data and information on stress rupture and tensile properties of these joints are included. (auth)

**30118** JOINING METHODS APPLIED TO SINTERED ALUMINUM PRODUCTS. Aastrup, P. (Danish Central Welding Institution, Copenhagen); Moe, A.; Knudsen, P. Met. Soc. Conf., 47: 813-44(1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

A major problem in the joining of dispersion-strengthened materials is to prevent destruction of the specific distribution of dispersed particles and thus avoid a decrease in high temperature strength. Gas content may be another important factor since the presence of a large amount of gas in the material is likely to result in a porous welding zone. Welding methods applied to sintered aluminum products are reviewed. Experiments related to the flash welding process and types of fusion welding are treated in more detail. SAP-SAP joints of satisfactory high temperature strength and tightness have been made by flash welding. In the special versions of fusion welding, sound joints are obtained by using aluminum as filler material under closely controlled conditions. Good joint strength and tightness at elevated temperature is effected using these methods and a suitable joint design. (auth)

**30119** DIFFUSION BONDING OF DISPERSION-STRENGTHENED NICKEL ALLOYS. Metcalfe, A. G. (Solar, San Diego, Calif.). Met. Soc. Conf., 47: 783-812(1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

Experience with the principal methods of joining TD Nickel is reviewed leading to the choice of solid state bonding for this type of alloy. Several diffusion bonding systems have been found that give high joint efficiency at room temperature. Problems encountered with these systems include joint stability on exposure at elevated temperatures, and failure of TD Nickel at high temperatures. Joint instabilities include void formation in the joint on high temperature annealing. With the nickel-palladium system, the origin of voids appears to be the Kirkendall effect; with other systems gas evolution is a contributing factor. Joint efficiencies are consistently 100% at low temperatures for butt and lap joints. Efficiencies decrease at 1000°F and higher because of the onset of intergranular failures. In fatigue, lap joints show low efficiencies at room temperature as a result of the notch effect at the change of section. Joint design is critical for use of this material. (auth)

**30120** CLEANING AND STABILIZATION OF DISPERSION-STRENGTHENED MATERIALS. Weeton, John W.; Quatinetz, Max (Lewis Research Center, Cleveland). Met. Soc. Conf., 47: 751-80(1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

A method for producing stable dispersion strengthened materials from mechanically produced blends of metal plus oxide powders was demonstrated. The method depends upon the controlled cleaning and densification of partially consolidated thin shapes. It is surmised that the use of thin shapes permits easy access of the cleaning gas to all of the material and the thorough removal of the gaseous impurities and reaction products and prevents agglomera-

tion of the stable oxides. A fine ball milled blend of nickel plus alumina, with good microstructural parameters was made into coins by either wet or dry compaction. The coins were cleaned at 2000°F and annealed at 2300 and 2600°F in hydrogen. Although some agglomeration was noted, both methods gave products which retained ultrafine oxide particles and showed relatively good stability even after annealing at 2600°F. The dry coins did not sinter as completely as those produced by wet compaction and the particle size increase as a result of annealing was somewhat greater. A nickel plus thoria composite with unusually good microstructural parameters was also produced from a ball milled blend. Furthermore, it is believed that the method may have aided in the reduction of chromium oxide in a chromium bearing nickel alloy and possibly eliminated sulfur (which is known to promote oxide agglomeration) in blends of nickel and thoria. (auth)

**30121** LABORATORY AND ENGINEERING STUDIES OF SOL-GEL PROCESSES AT OAK RIDGE NATIONAL LABORATORY. Wymer, R. G. (Oak Ridge National Lab., Tenn.). pp 131-72 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

A brief description of a model for sols, based largely on studies on $ThO_2$ sols, is given. Processes based on solvent extraction of nitrate ion by secondary amines to prepare $ThO_2-UO_2$ and $UO_2$ sols are discussed, and the flow sheets and equipment used in preparing these sols are illustrated. A method suitable for preparing 150-g batches of $PuO_2$ as sol is described, along with the properties of the typical $PuO_2$ and $UO_2-PuO_2$ products. Demonstrated processes for preparing, drying, and firing microspheres of $ThO_2$, $ThO_2-UO_2$ are described, and results of experiments on low-energy compaction of microspheres in tubes to form fuel elements of predetermined density are discussed. Miscellaneous sol-gel processes for preparing carbides, porous oxides, nitrides, and carbonitrides are briefly described. (auth)

**30122** OXIDE DISPERSION STRENGTHENING. Second Bolton Landing Conference, Bolton Landing, New York, June 27-29, 1966. Ansell, George S.; Cooper, Thomas D.; Lenel, Fritz V. (eds.). Metallurgical Society Conferences, Volume 47. New York, Gordon and Breach, Science Publishers, 1968. 918p. $56.00. (CONF-660626).

A total of 29 papers was presented at the conference. A separate abstract was prepared for each of 23 papers. Papers for which no abstracts were prepared are concerned with shear of dispersion-hardened crystals, mechanisms of dispersion-strengthening, dispersion-stored energy, stability of dispersed systems, interfacial energy of Au and $Au-Al_2O_3$ systems and interfaces in copper-oxide systems. (J.R.D.)

*For abstracts of individual papers see: 29992, 30033, 30105, 30112-30120, and 30149-30159.*

**30123** COST OF COATED-PARTICLE FUEL. Bairiot, H. (Belgonucleaire, Brussels). pp 115-18 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

A tentative appraisal of the economic effect of the fabrication process for producing kernels for coated particles is given. It is demonstrated that the sol-gel processes, which are capable of producing satisfactory spheres of small diameter, may cause a sensible decrease in the cost of coated particles and in the electricity generating cost. (auth)

**30124** STATUS REPORT FROM ITALY. SOL-GEL RESEARCH AND DEVELOPMENT. Zifferero, M. (CNEN, Rome). pp 9-20 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

The ability of sol-gel processes to produce fissile or fertile materials (or a homogeneous mixture of both), the density of which can be brought close to the theoretical value by sintering at low temperature, and their unique capacity to produce these materials in the form of microspheres of desired dimensions having superior strength, smoothness and sphericity are discussed. These combined properties make them ideally suited for the production of fuel rods by low-energy vibratory compaction. Sol-gel activities in Italy are therefore primarily intended for high-temperature gas reactor fuels (i.e., fuel kernel dispersed in a graphite matrix) and for the development of fast breeder fuels (i.e., vibratory compacted pins). Two different processes have been developed independently. Recently, however, it was decided to explore jointly the application of the SNAM method to the production of mixed urania-plutonia microspheres. CNEN research and development is described in greater detail. Information is largely based on previous data and has been brought up-to-date with some recent results. Research on sol-gel includes basic chemistry of actinides in colloidal solution, and the mechanism of gelification and sintering; process chemistry and establishment of flow-sheets; process development and research on specific unit operations; and product evaluation, irradiation testing, and economics. (auth)

**30125** SOL-GEL PROCESS ON PLUTONIUM OXIDE AT THE EUROPEANINSTITUTE FOR TRANSURANIUM ELEMENTS. Louwrier, K. P.; Ronchi, C.; Steemers, T.; Zamorani, E. (EURATOM, Karlsruhe, Ger.). pp 97-106 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

Several methods were investigated to produce a plutonium-oxide sol that could be converted into microspheres. A critical factor appeared to be the $NO_3/Pu$ ratio of the sol. All sols were made by peptization of a plutonium-oxyhydrate with an appropriate amount of $HNO_3$. Methods tested to produce sols with a low nitrate content were dialysis of plutonium oxide sol with a high nitrate-to-plutonium ratio of 0.8 to 1.0, baking a plutonium oxide gel with a high nitrate-to-plutonium ratio of 0.8 to 1.0 at 120 to 160°C for several hours and redispersing the final product, and precipitation of plutonium-oxyhydrate under such conditions that direct dispersion into dilute $HNO_3$ produced a sol with a nitrate-to-plutonium ratio of 0.2 to 0.3. The last appeared to be the most reliable and efficient one. The feasibility of producing microspheres from different sols was tested with the method of water extraction through 2-ethylhexanol. A nitrate-to-plutonium ratio under 0.35 was found to be essential for the formation of sound microspheres. The properties of the $PuO_2$ were investigated by electron microscopy. It seems that the sol is polydispersed and consists of amorphous particles. Sols aged far more than a year reveal no crystalline structure by electron diffraction. Drying and calcination of the microspheres coming from the ethylhexanol column are discussed. 100 g of $PuO_2$ microspheres were produced using the third method. An outline of the sol-gel program in the European Institute for Transuranium Elements is presented. (auth)

**30126** PRODUCTION OF THORIUM- AND PLUTONIUM-DILUTED SOL-GEL PARTICLES. Bairiot, H.; Vanhellemont, G. (Belgonucleaire, Brussels). pp 85-90 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

The sol-gel process was utilized to determine the feasibility of producing spherical particles containing $ThO_2$, $PuO_2$ and C in the proportion necessary to fabricate thorium-plutonium carbide kernels for coated particles. The process was extended successfully to the preparation of thorium and plutonium gels having a significant excess of carbon. Other experiments were performed to test the feasibility of incorporating $UO_2$ powder into the gel spheres. With this technique U-to-Th ratios of up to 9/1 were obtained. (auth)

**30127** SOL-GEL PROCESSES AT TOKAI. Muto, T. (Power Reactor and Nuclear Fuel Development Corp., Tokai, Japan). pp 51-9 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

The development of sol-gel processes in Japan has mainly been concentrated on the preparation of dense $UO_2$ and $UO_2-PuO_2$ spheres which can be used for vibratory compaction. Preparation of the dense $UO_2$ spheres on the gram-to-kilogram scale has been carried out to improve the processes. Preliminary experiments applying the sol-gel process have also been performed on $UO_2$ pellets and uranium monocarbide spheres. (auth)

**30128** STATUS REPORT FROM YUGOSLAVIA. RESEARCH ON SOL-GEL PROCESSES. Popovic, B. (Federal Nuclear Energy Commission, Belgrade); Zivanovic, B. M. pp 47-8 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

A brief survey describes the background of nuclear power research in Yugoslavia, together with the economic considerations. Yugoslav experience with sol-gel processes is outlined. (auth)

**30129** STATUS REPORT FROM THE UNITED STATES OF AMERICA. SOL-GEL WORK ON CERAMIC FUEL PRODUCTION. Wymer, R. G. (Oak Ridge National Lab., Tenn.). pp 43-5 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

A brief survey is given of the development and progress on sol-gel methods at six companies and the Oak Ridge National Laboratory. A broad range of ceramic materials is being studied at ORNL and includes $ThO_2$, $UO_2$, $PuO_2$, $ZrO_2$, and carbides, nitrides, and carbonitrides. (J.C.W.)

**30130** STATUS REPORT FROM THE UNITED KINGDOM. SOL-GEL AND GEL-PRECIPITATION PROCESSES. Hardy, C. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 33-42 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

Sol-gel and gel-precipitation processes are defined and examples are given of the laboratory-scale preparation of $ThO_2$, $UO_2$, $ThO_2-UO_2$, $UO_2-ZrO_2$ and $(Th,U)C_{1.4}$ particles of controlled composition, size, and shape for nuclear fuels. Processes have also been developed to produce metal powders, and alumina- and zirconia-based metal oxides with applications in the fields of powder metallurgy, refractories and ceramics. Basic physico-chemical studies of the structure and properties of sols and gels and of oxides derived from them are reviewed. Progress on the scale-up of the processes and equipment is described, and the potential technical and economic advantages of these processes are assessed in comparison with conventional processes for the fabrication of pelleted, granular and spherical nuclear fuels for a number of types of reactor. (auth)

**30131** STATUS REPORT FROM THE NETHERLANDS. SOL-GEL FUEL STUDIES. Hermans, M. E. A.; Kanij, J. B. W.; Noothout, A. J.; Van Der Plas, T. (N. V. Kema, Arnhem, Netherlands). pp 21-32 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

Sol-gel processes developed for the production of uranium-containing thorium oxide include the external alkaline gelation process for fuel particles smaller than 25 μm, the internal alkaline gelation process applicable to particles up to a few millimeters (an ammonia donor is used in the sol), and the hot gelation process, which is based on a dehydration by water emulsification at high temperature. A large number of physico-chemical problems is involved in processes of this type, and studies have been performed to understand the underlying chemistry. Industrial interest in the sol-gel processes for nuclear fuel is growing in the Netherlands under the stimulation of the electric power producers who consider the sol-gel route as a potential source of savings in the fuel cycle costs. (auth)

**30132** EVALUATION OF SOL-GEL METHODS AT CNEN WITHIN THE FRAMEWORK OF THE PLUTONIUM UTILIZATION PROGRAM. Schileo, G. (CNEN, Rome). pp 107-11 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

The ability to produce dense plutonia, homogeneous urania-plutonia or thoria-plutonia microparticles at any desired ratio by means of sol-gel processes has been demonstrated on a laboratory scale. An irradiation program is underway to evaluate the plutonium-bearing fuels together with an economic study based on a comparison of the fabrication processes. (auth)

**30133** STATUS REPORT FROM THE CZECHOSLOVAK SOCIALIST REPUBLIC. WET WAY PROCESSES FOR PREPARING NUCLEAR CERAMIC MATERIALS. Baran, V. (Inst. of Nuclear Research, Prague). pp 3-7 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

The basic premise for the Czechoslovak investigations of wet way processes is given. The chemical state of uranium(IV) hydroxide precipitate, chemical and granulometric changes during the growth of particles, interaction of valence states of uranium ions, and some aspects of electro-reduction are discussed. (auth)

**30134** IMPROVEMENTS IN OR RELATING TO REFRACTORY PRODUCTS. (to Gulf General Atomic Inc.). British Patent 1,152,494. May 21, 1969. Priority date June 23, 1965, United States.

A method for making high temperature refractory materials with improved physical and structural properties consists of heating a refractory material matrix to induce reactions with a binder forming a liquid phase at a temperature below the melting or vaporization temperature of the refractory. While the binder is in a molten form, compressive stresses are applied in one direction and the body expands in a direction perpendicular to the direction of compression. The refractory formed is a crystalline structure with the binder distributed throughout the pores. The invention is illustrated using particulate carbon refractory and particulate Al, Mo, U, or Zn binders. (F.S.)

**30135** METALLOGRAPHIC PREPARATION OF MICROSPHERES WITH LOOSE CONCENTRIC SHELLS. Bertino, James P. (Los Alamos Scientific Lab., N. Mex.). Proc., Annu. Tech. Meet., Int. Metallogr. Soc., Inc., First, 37-42(1968).

From 1st Annual Technical Meeting of the International Metallographic Society, Denver, Colo. See CONF-681107.

Different pyrolytic carbons reorganize to different extents when annealed at high temperatures. If greatly dissimilar pyrolytic carbons are situated as adjacent concentric layers on a small spherical substrate, annealing leads to the formation of voids between layers and delaminations of varying complexity within some layers. The resulting microspheres have a fragile internal structure, best described as a series of loosely fitting shells, with a varying degree of attachment to each other. Conventional techniques, supplemented by a series of additional fine grinding plus epoxy resin re-impregnation steps, permits the metallographic preparation of these specimens. To a large degree the internal structure can be preserved in great detail. (auth)

**30136** STUDIES FOR THE CHARACTERISTICS OF SINTERED URANIUM DIOXIDE FUEL. PART I. FABRICATION STUDY OF HIGH DENSITY SINTERED $UO_2$ PELLETS. Makino, Munetsugu (Hitachi, Ltd., Ibaraki, Japan). Funtai Oyobi Funmatsuyakin, 16: 29-37(Mar. 1969). (In Japanese).

Sintered $UO_2$ pellets of high densities are used as fuel for water-cooled reactors. Relations between properties such as bulk density, tap density, specific surface area, and average particle size were examined along with compatibilities or sinterabilities of as-received, oxidation-reduction treated, or ball-milled powders. In these experiments, powders were compacted at 2 to 7 $t/cm^2$ and were sintered for 1 to 10 hours at 1400 to 1650°C in an atmosphere of cracked ammonia. The specific surface areas of $UO_2$ powders increased with increasing oxidation-reduction cycles; however only small change was observed in the ball-milled $UO_2$ powders. In contrast to the ball-milled $UO_2$ powder, the green density of the oxidation-reduction treated $UO_2$ decreased with increasing specific surface area. Ball-milling and oxidation-reduction treatment improved the sinterability. The activation energy of the densification of $UO_2$ during sintering in cracked ammonia was calculated. It was found that the densification factors are proportional to the specific surface area of as-received or activation treated powders. (auth)

**30137** ISOSTATIC COMPACTION OF METAL POWDERS. Morgan, W. R.; Sands, R. L. (BSA Group Research Centre, Birmingham, Eng.). Met. Rev. (Publ. in Metals Mater.), 14: 85-102(May 1969).

Developments in isostatic compaction processes are reviewed. The cold isostatic process is compared with the die process for metal powders. The techniques and equipment used for both cold and hot isostatic compaction are described. The advantages of each process and the principal applications in the field of metal powders, ceramics, refractories, and cermets are discussed. An outline is given of methods reported for explosive isostatic compaction. (92 references). (UK)

## *Properties Evaluations*

*Refer also to abstracts 29017, 29071, 29072, 29108, 29123, 29968, 30010, 30030, 30033, 30113, 30114, 30115, 30122, 30193, and 31236.*

**30138** (AERE-R-4657) PROPERTIES OF REFRACTORY MATERIALS. Burnett, S. J. (Atomic Energy Research Establishment, Harwell (England)). June 1964; Reprinted Apr. 1969. 326p. Dep. CFSTI. UK 42s. 0d.

The physical, mechanical, and thermochemical properties of some refractory materials melting above 1700°C are collected and listed under each material. Where applicable the information is also presented graphically for each property to enable mate-

rials comparison. Tables of available compatibility data for some of the materials are also included. Some 196 materials are covered, although in many cases little information is available. (auth)

**30139** (GEAP-5683) THERMODYNAMIC ANALYSIS OF POSSIBLE CHEMICAL INTERACTIONS IN THE SYSTEM: $UO_2$-$PuO_2$ FUEL-SODIUM-STAINLESS STEEL. Aitken, E. A. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). July 1968. Contract AT(04-3)-189. 61p. Dep. CFSTI.

Results of a literature search on the possible reactions between Na, fuel, and cladding are presented. An analysis of thermal gradient effects on the fuel and cladding phases is presented and a number of mechanisms for predicting material flow in thermal gradients are described. The magnitude of thermally induced sodium-fuel reactions resulting in fuel swelling is evaluated and conditions useful in controlling such reactions are described. The mechanisms of cladding oxidation by hyperstoichiometric fuels are analyzed. Recommendations for research on aspects of Na-fuel-cladding compatibility are included. (J.R.D.)

**30140** (GEMP-1010, pp 260-90) FAST BREEDER REACTOR THERMOCOUPLE DEVELOPMENT (1414). Baxter, W. G.; Kuhlman, W. C. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.).

The fabrication of ORTC-III is 90 percent complete and all fabricated parts were delivered for final assembly of the inpile test cartridge. Three mixed oxide ($UO_2$-$PuO_2$) fuel pins were fabricated and delivered. Small-diameter (0.112-cm OD) hafnia thermocouple insulator tubing was produced. The tubing contained two 0.031-cm-diameter equally spaced holes. A second group of W-25Re small-diameter tubes (0.173-cm-OD - 0.125-cm-ID) were also fabricated. These tubes were fabricated using a solid mandrel and the ID finish was improved. Chemical purification of thoria insulator materials was initiated and is being considered. The electrical resistivity apparatus was reactivated and indicated a 2300°C capability. The thermal cycling of type K duplex thermocouples 0.158-cm OD in an electrically heated, steam-cooled thermal cycling rig was activated. (auth)

**30141** (LA-4128) CMF-13 RESEARCH ON CARBON AND GRAPHITE. Report No. 8. Summary of Progress, November 1, 1968-January 31, 1969. Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). Mar. 21, 1969. Contract W-7405-eng-36. 31p. Dep. CFSTI.

Mix formulations, molding conditions, and properties of hot-molded anisotropic graphites are tabulated. Filler-particle characteristics on the properties of a graphite made from that filler are predictable. Experiments were performed on binary filler materials. A systematic comparison was made of the properties of the extruded graphites made from the fillers. (J.C.W.)

**30142** (NYO-3886-3) IMPROVED COMPATIBLE MATERIALS FOR THERMOELECTRIC POWER GENERATION. Midpoint Report. Dismukes, J. P.; Kudman, I.; Moss, H. I. (Radio Corp. of America, Princeton, N. J. RCA Labs.). Apr. 1969. Contract AT(30-1)-3886. 32p. Dep. CFSTI.

An examination of the hot-pressing procedure of n-type $Pb_{.91}Ge_{.09}Te$ alloys has been undertaken. This has included the effects of the temperature and duration of both hydrogen and vacuum annealing of the powders, and the effects of stoichiometry (Pb/Te ratio) and composition (Pb/Ge ratio) of the starting material. It was found that hydrogen annealing at a temperature exceeding 600°C is necessary to ensure the removal of oxygen contamination. Long vacuum anneals at elevated temperatures are to be avoided, presumably because of loss of dopant and/or one of the constituents. The Pb/Ge ratio markedly affects both the solubility of the n-type dopant, and at constant doping affects the resistivity. The problems previously observed with hot-pressed material have been eliminated. Encouraging life-test behavior has already been observed, and further life-testing is continuing. Apparatus for thermocouple efficiency measurements and in-gradient testing has been constructed. (auth)

**30143** (ORNL-tr-2124) DYNAMIC PROPERTIES OF CONCRETE EXPOSED TO HIGH TEMPERATURE. Kawahara, Yujun; Haraguchi, Akira. Translated for Oak Ridge National Lab., Tenn., from Konkurito Janaru, 7: No. 3, 12-19(1969). 16p. Dep. CFSTI.

The dynamic properties such as compressive strength, elastic modulus, and Poisson ratio of concrete exposed to 80°C were measured on specimens subjected to six different sets of conditions including hardening at high temperature, curing in the sealed state to prevent water loss, and varying the curing period from the time of casting to the time of the high-temperature exposure. The unit weight of concrete cured at 20°C for at least three months after casting drops sharply in the initial week of hardening at 80°C but the change in unit weight in the end is but 5% less than the initial unit weight (one day after casting). The compressive strength of concrete which has been moisture-cured for at least three months at 20°C to allow the hydration of cement to progress sufficiently and then hardened at 80°C is very slightly affected by the high-temperature hardening. When there is no moisture curing, the strength loss ratio is more than 50%, indicating the effects of high-temperature hardening. The compressive strength of concrete sealed immediately after casting and kept in this sealed state at 20°C for at least three months followed by curing in the sealed state at 80°C is 15 to 20% lower than that of concrete cured in the sealed state at 20°C for the same period. The effect of high temperature on the static elastic modulus of concrete is greatly affected by the presence of moisture in the concrete. The Poisson ratio of concrete cured at 80°C tends to be somewhat smaller than that of concrete cured at 20°C. The degree of decrease is about 0.14 in the dry state and about 0.17 in the sealed state. (J.C.W.)

**30144** THERMAL FEATURES OF SANDWICH NUCLEAR FUEL ELEMENTS. Betta, Vittorio (Univ., Naples). Termotecnica (Milan), 22: 553-7(Dec. 1968). (In Italian).

In a previous study the problem of the determination of the thermal conditions of ceramic-type fuel elements developed with layers of high conductive metallic materials was considered. The relations developed in the previous study were evaluated with a numerical computer for more generalized conditions. The limits of validity of the previously developed relations for the calculations of the maximum temperature attained in the sandwich elements were verified. (tr-auth)

**30145** HEAT PRODUCTION FROM INTERIOR FRICTION IN IRRADIATED GRAPHITES. Merlin, J. (Institut National des Sciences Appliquees, Lyon); Gobin, P.; Jouquet, G.; Rappeneau, J. J. Nucl. Mater., 31: 138-52(June 1969). (In French).

Measurement of the internal friction coefficient as a function of temperature has been used as a means of investigating defects created in artificial graphites by neutron irradiation at small doses (lower than $2 \times 10^{20}$ n/cm$^2$) and at room temperature. Observations carried out on a compressed pyrographite, of properties very similar to those of the single crystal, show a behavior resembling that found in standard nuclear graphite, with differences inherent to the polycrystalline nature of the latter material. The internal friction spectra plotted between -180 and +500°C at frequencies of about 1 Hz and relative strain amplitudes of the order of $10^{-5}$ revealed several distinct energy absorption phenomena. A continuous background is noted which can be connected with the displacement of the dislocation bands, the level depending on the irradiation dose. A dislocation-point defect interaction peak occurs at around 0°C, and is influenced by the irradiation dose. A relaxation peak at about +90°C (frequency 1 Hz), appears only for irradiation doses not greater than $10^{20}$ n/cm$^2$ and apparently attributable to di-interstitial reorientations. An internal friction maximum shows a direct connection with the restoration of the modulus after irradiation, which takes place between 200 and 500°C and which can be ascribed to a reorganization of irradiation-induced defects. These results are the basis of a definition of the nature and developments of the defects after neutron irradiation. The presence of interstitial defects of the type suggested by Wallace affords an interpretation of most of the phenomena observed. (tr-auth)

**30146** SOLUBILITY OF NITROGEN IN VANADIUM. Monroe, Frank M.; Cost, James R. (Ford Scientific Lab., Dearborn, Mich.). Trans. Met. Soc. AIME, 245: 1079-82(May 1969).

The solubility of nitrogen in vanadium is determined at 275 to 575°C by measuring the height of the nitrogen internal friction peak of equilibrated V-N alloys. The proportionality constant at 275°C between the internal friction peak height ($Q^{-1}$) and the atom percent nitrogen in solution is found to be 0.095 per at. % for nitrogen concentrations up to 0.8 at. %. The heat of solution of the nitride in vanadium is 5500 cal per mole. The solubility of nitrogen in the Group V metals is discussed. (auth)

**30147** EVOLUTION OF PYROCARBON TOWARD GRAPHITE. Marie, Jacques (Division des Etudes Nucleaires, Gennevilliers, France); Rappeneau, Jean. J. Chim. Phys., Special No., 141-8 (Apr. 1969). (In French).

From 18th Annual Meeting on Carbonization and Graphitization, Paris, France. See CONF-680620.

Evolution of pyrocarbon towards the single crystal is compared during heat treatments with and without compression. Moreover the influence of thermal annealing at temperatures above 3000°C on the samples is examined. Characteristics which have been mea-

sured on some samples include density, electric resistivity $\rho$ on the crystallographic directions a and c, thermal conductivity K and thermal expansion $\alpha$ on the same directions, magneto-resistance ($\Delta\rho/\rho$), and HALL coefficient A on the direction $\alpha$, crystalline orientation of carbon layers, modulus of shearing. Treatment of pyrocarbons at 3000°C under load provides better results than heating to 3500°C without load. Annealing at 3500°C of pyrocarbons already heat-treated at 3000°C does not seem to improve appreciably the characteristics of the material. (tr-auth)

**30148** ASPECTS FONDAMENTAUX DE LA CARBONISATION ET DE LA GRAPHITATION. 18e REUNION DE LA SOCIETE DE CHIMIE PHYSIQUE, PARIS, 26, 27, ET 28 JUIN 1968. (Fundamental Aspects of Carbonization and Graphitization. 18th Meeting of the Chemical Physics Society, Paris, June 26, 27, and 28, 1968). J. Chim. Phys., Special No., 1-184(Apr. 1969). (In French and English). (CONF-680620).

A total of 34 papers was presented at the conference. A separate abstract was prepared for each of three papers. Papers for which no abstracts were prepared are concerned mostly with aspects of carbonization and graphitization not in the scope of NSA. (J.R.D.)

*For abstracts of individual papers see: 30147, 30189, and 30194.*

**30149** DISPERSION-STRENGTHENED NICKEL BASE ALLOYS. Arnold, D. B.; Klingler, L. J. Jr. (E. I. du Pont de Nemours and Co., Baltimore). Met. Soc. Conf., 47: 611-35 (1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

Scale-up was undertaken on two nickel base alloys strengthened by both ultra fine dispersions of thoria and solid solution additions. A nickel molybdenum alloy, TDNiM, containing 21% Mo and 3% $ThO_2$ has improved strength in the 1200 to 2000°F temperature range over that of TD Nickel. A nickel chromium alloy, TDNiC, containing 20% Cr and 2% $ThO_2$ has excellent oxidation resistance at temperatures to 2400°F. The alloys produced by the additions of molybdenum and chromium to the Ni–$ThO_2$ base exhibit strengthening mechanisms in addition to those operative in commercial TD Nickel. Mill products of bar, sheet, and tubing of TDNiC and bar of TDNiM are being produced. (auth)

**30150** PROTECTIVE COATINGS FOR DISPERSION-STRENGTHENED NICKEL. Monson, L. A. (E. I. du Pont de Nemours and Co., Inc., Newport, Del.). Met. Soc. Conf., 47: 563-607 (1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

A Cr/Al coating for TD-Nickel was defined which can be designed to give protective life-times in a laboratory cyclic-oxidation test of over 1000 hours at 2200°F or over 150 hours at 2400°F. Process parameters were investigated and specific coating details outlined. A typical 500 hour coating at 2200°F contains about 0.030 g/cm$^2$ Cr and 0.0025 g/cm$^2$ Al, applied in two steps. Chromium is applied by burying the pieces to be coated in a blended pack containing 20 wt % –100 mesh Cr, 0.5 wt % $NH_4Cl$ and the balance, –100 mesh $Al_2O_3$. These are heated to 2300°F for 24 hours in a protective atmosphere. Aluminizing is carried out in a pack consisting of 20 wt % of –100 mesh alloy (75 Cr–25 Al), 0.1 wt % $NH_4Cl$ and balance, –100 mesh $Al_2O_3$. These are heated to 1800°F for 3 hours. Porosity developed in coated TD-Nickel composites. This porosity may increase the coating lifetime. Oxidation phase sequence has been identified as $\alpha$–$Al_2O_3$ → $Cr_2O_3$ → Spinels → NiO. No deleterious effects were observed in tensile, stress-rupture or thermal fatigue tests at temperatures up to 2200°F as a consequence of coating application or subsequent high temperature exposure in air. The microstructures of coated TD-Nickel were identified and variations defined as functions of time and temperature. Basic coating phases are fcc solid solution of Cr and Al in Ni ($\gamma$), bcc solid solution of Ni and Al in Cr ($\alpha$) and NiAl with dissolved Cr ($\beta$). (auth)

**30151** VISUAL OBSERVATIONS ON THORIA DISPERSIONS IN NICKEL ALLOYS. Sims, Chester T. Met. Soc. Conf., 47: 489-93 (1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

Samples of $^{20}$Cr–Ni–$ThO_2$ and $^{20}$Cr–Ni–ThO alloys were exposed for 209 and 2010 hr at 2000°F under no stress. Results of comparisons indicate that Cr at 20% does not reduce the stability of thorium oxide in nickel. Although there was little difference in stability of the thorium oxide, fine structures were developed by recrystallization showing twin-like banding in the $^{20}$Cr–Ni–ThO alloy and a grain boundary network developed in the $^{20}$Cr–Ni–$ThO_2$. (F.S.)

**30152** SOME OBSERVATIONS ON THE STABILITY OF OXIDE DISPERSIONS IN METALS. Seybolt, A. U. (General Electric Co., Schenectady, N. Y.). Met. Soc. Conf., 47: 469-87 (1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

The factors important for the growth in average diameter of an oxide dispersion in a metal matrix are briefly reviewed, assuming rate control by a diffusion process in the metal matrix, and comparisons are made between the observed and calculated growths. After making this comparison for a number of cases described in the literature, it has been found that in general the agreement is reasonably good, but the experimental data available for comparison with theory are so limited that one cannot be certain at present that the assumed model is correct. More experimental evidence covering a wider range of variables is needed, coupled with better control of some of the experimental parameters. (auth)

**30153** MECHANISMS OF DEFORMATION IN DISPERSION-HARDENED ALLOYS. Guyot, P. (Univ. of California, Berkeley). Met. Soc. Conf., 47: 405-27 (1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

The mechanisms of plastic deformation occurring in alloys with a fcc matrix and in which the incoherent second phase dispersed particles are generally not deformed with the matrix, are described. At low temperatures these mechanisms are well understood. A model of mobile dislocations cutting through the pierce dislocation forest agrees with the experimental results; the hardening is due to the steep increase of dislocation density with the strain. The second phase plays an indirect part (pinning or multiplication of dislocations). At a high enough stress (or strain) cross slipping can be induced, determining a cell structure. At high temperatures various processes can be effective: cross slipping and particle limited climb determine the motion of dislocations in the matrix; for temperatures near the melting point of the matrix, these alloys generally present very high activation energies steeply varying with the stress and the thermal activation of the junction reactions between attractive dislocations explains quite well the experimental measurements. (auth)

**30154** STRENGTHENING MECHANISM IN DISPERSION-STRENGTHENED NICKEL. Fraser, R. W.; Evans, D. J. I. Met. Soc. Conf., 47: 375-403 (1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

The high temperature tensile properties of nickel-thoria wrought products are discussed in terms of their characteristic fibrous microstructure. The high temperature tensile strength of these materials can be described using a fibrous composite model and this model offers an explanation for the strengthening increment associated with the working of wrought oxide dispersion strengthened materials. (auth)

**30155** INCREASED HIGH TEMPERATURE STRENGTH BY THE THERMO-MECHANICAL TREATMENT OF DISPERSION-STRENGTHENED ALLOYS. Grierson, R.; Bonis, L. J. (Ilikon Corp., Natick, Mass.). Met. Soc. Conf., 47: 357-73 (1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

The high temperature strength of TD nickel has been reported to be strongly dependent on the previous thermal and mechanical history of the material. The response of TD nickel to various thermo-mechanical treatments is considered in terms of the existence of annealing resistant elastic strains in the nickel matrix of the alloy. A correlation between the high temperature strength of TD nickel and the level of the elastic strains present is shown. (auth)

**30156** HIGH-TEMPERATURE CREEP OF Ni–$ThO_2$ ALLOYS. Wilcox, B. A.; Clauer, A. H. (Battelle Memorial Inst., Columbus, Ohio). Met. Soc. Conf., 47: 323-55 (1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

The steady-state creep behavior of TD Nickel (Ni + 2 vol % $ThO_2$), which has a very fine fibrous grain structure, and several recrystallized experimental Ni–$ThO_2$ alloys is discussed in terms of the structural changes attending high-temperature creep deformation. Over the temperature range 0.6 to 0.8 $T_m$, a stress-independent apparent activation energy of 190 kcal/mole characterizes the temperature dependence of the steady-state creep rate of TD Nickel. The stress dependence of the creep rate is given by $\dot{\epsilon}_s \propto \sigma^m$ where m has an unusually high value of 40. Structural examination of crept TD Nickel specimens by transmission electron microscopy and replica electron fractography and metal-

lography shows that the most important mode of high-temperature creep deformation is grain-boundary sliding, and that there is very little change in the dislocation structure as compared with uncrept material. An activation energy equal to that for self-diffusion in nickel (64 kcal/mole) is found for the high temperature creep of several recrystallized Ni–$ThO_2$ alloys (1 to 3 vol % $ThO_2$). A modified version of the Ansell–Weertman climb theory for coarse-grained dispersion strengthened metals is applied to creep results on these alloys. (auth)

**30157** AN ELECTRON TRANSMISSION STUDY OF OXIDE PARTICLE STATISTICS IN TD NICKEL ALLOY. Inman, M. C.; Smith, P. J. (Pennsylvania State Univ., University Park). Met. Soc. Conf., 47: 291-321(1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

It appears that even for relatively long anneal times (200 hrs.), the complete recrystallization of heavily cold worked TD Nickel is delayed at 700 to 900°C. The yield stress (actually critical resolved shear stress) of single crystal material lies in the range 18 – 40 kg $mm^{-2}$ where the upper and lower limits are determined by the assumption of a random or an FCC type distribution of thoria particles. The tensile yield stress reported for cold worked TD Nickel annealed 1 hour at 1200°C is 30 kg $mm^{-2}$ (3) and 33 kg $mm^{-2}$ (11) after 1 hour at 1440°C. If it is assumed that tensile stress in polycrystals is approximately twice the shear stress, the result obtained from the Orowan model is in reasonably good agreement with the available data. (auth)

**30158** FRACTURE OF INTERNALLY OXIDIZED COPPER ALLOYS. Palmer, I. G.; Smith, G. C. Met. Soc. Conf., 47: 253-90(1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

The fracture behavior of copper alloys containing about 2% by volume of particles of silica, beryllia, and alumina, produced by internal oxidation, has been studied macroscopically and by thin foil electron microscopy. The oxide particles were mostly in the hundred Å size range, and single crystal and polycrystal strip specimens have been fractured at 293 and 77°K. Thin foils have been prepared by a disc technique and obtained from areas very close to the fracture surfaces. Failure occurs at particle-matrix interfaces, resulting in the formation of voids on the oxide particles: the failure has been interpreted in terms of the build-up locally of a critical dislocation density. Voids form first on the larger particles of a given distribution, and this size dependence is shifted to a smaller particle size with decrease in temperature; this effect is attributed to thermally activated dislocation cross slip. At the start of macroscopic necking voids exist on fewer particles at 293°K than at 77°K, and this explains the increase with temperature of the percentage necking at fracture. Within the necked regions of specimens highly localized zones of shear are found, in which there is extensive void growth; these zones correspond to coarse slip lines observed on the specimen surfaces. Final separation appears to occur by the coalescence of voids, with extensive coalescence being confined to the fracture surface itself. Particles of oxide in grain boundaries behave in much the same way as those in the grain interior, provided the concentration of particles is similar. The nature of the oxide particles does not appear to affect significantly the observed behavior. (auth)

**30159** THE MECHANICAL PROPERTIES OF SINGLE CRYSTALS OF COPPER CONTAINING DISPERSIONS OF BeO PARTICLES. Jones, R. L.; Kelly, A. (Cambridge Univ., Eng.). Met. Soc. Conf., 47: 229-52(1968).

From Second Bolton Landing Conference, Bolton Landing, N. Y. See CONF-660626.

Tensile shear strengths and rates of work hardening of single crystals of Cu containing dispersions of BeO produced by internal oxidation were measured at 72 to 473°K to test theories of yield stress and work hardening behavior of crystals containing dispersions of hard discrete particles. Results support the theory of yield mechanism and the theory of work hardening behavior. (F.S.)

**30160** SPECIFIC HEATS, THERMAL DIFFUSIVITIES, AND THERMAL CONDUCTIVITIES OF ZIRCONIUM HYDRIDES CONTAINING 4 at. pct U. Young, W. A. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. Trans. Met. Soc. AIME, 245: 971-9(May 1969).

Polynomial functions of temperature were obtained for the specific heats, thermal diffusivities, and thermal conductivities of zirconium hydrides containing 4 at. % U. Three hydrides (H/Zr atom ratios of 1.58, 1.65, and 1.70) were studied at 0 to 900°C and a fourth (H/Zr = 1.81) was studied at 0 to 760°C. The specific heats were determined from enthalpy measurements which were obtained using a unique drop calorimeter specifically designed for use with materials in which high temperature phase transitions and/or high dissociation pressures occur. Thermal diffusivities were measured by the flash method using a pulsed laser. The thermal conductivities were obtained as the product of specific heat, thermal diffusivity, and density. The specific heats agree, within 10%, with values derived using a theoretical model in which the hydrogen and zirconium atoms are treated as Einstein and Debye oscillators, respectively. (auth)

**30161** SOL-GEL PROCESSES FOR THE FABRICATION OF CERAMIC FUEL PARTICLES FOR HIGH-TEMPERATURE REACTORS. Bildstein, H. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Vienna). pp 81-4 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

Three types of product and procedure for oxide-containing particles and processes for oxide-containing kernels have been developed. Fuel particles from resin bonded metal-salt solutions are formed using resin components for the stabilization of droplets of solutions promoting the manufacture of ceramic particles based on both real solutions and sols. This process is extremely valuable if carbon diluted oxide kernels for ultra-high temperature applications are required. By variation of the production procedure kernels of melted carbides, carbon-diluted carbides, and carbon-diluted oxides can be obtained. By utilizing a process similar to that described in the preceding paragraph but with thorium oxide sols instead of metal-salt solutions, thorium oxide particles with high density have been obtained. To avoid the necessity of reducing the uranium to the tetravalent state for production of stable sols, a sol-gel process based on uranyl nitrate solutions, which are first converted to hydrated uranium peroxide, has been developed. This peroxide is transformed to a stable sol with tetraethyl ammonium hydroxide, which can be concentrated by evaporation under vacuum. Gelation is accomplished by the addition of diethyl-ester of malonic acid. The particles are obtained by spraying, dried by ethylhexanol and converted to the desired final product by suitable heat treatment. (auth)

**30162** HEAT TREATMENT OF SURFACE TENSION KERNELS FOR THE MANUFACTURE OF COATED PARTICLES. Aerts, L. (Belgonucleaire, Brussels); Bairiot, H.; Potdevin, H. pp 91-5 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

Various heat treatments were carried out to study the range of porosities obtained with normal gelled uranium–oxide particles. Experimental results are described. (auth)

**30163** VIBRATION COMPACTED $UO_2$ FUEL. II. EFFECTS OF WAVE FORM ON COMPACTED DENSITY. Hirose, Yasuo; Komori, Itaru (Hitachi Research Lab., Japan). J. Nucl. Sci. Technol. (Tokyo), 6: 229-36(May 1969).

A study was made on the effects of differences in input wave forms on densities obtained by compaction with vibration exciter. The input patterns included sinusoidal, triangular, saw-tooth, inverted saw-tooth, square, cyclic pulse, and inverted cyclic pulse waves. The highest density obtained for given acceleration was found to be with an input of saw-tooth wave at either 580 or 800 c/s. As a general trend, the characteristics reported previously for the case of sinusoidal vibration with respect to the influence of displacement and acceleration on the density obtained was found applicable to these other wave forms. The relationship, between frequency and density obtained was however found to vary widely, and this together with the surprisingly strong effect provided by the polarity of waves on compaction efficacy attests to the complexity of the effects of differences in wave form. (auth)

**30164** KINETICS OF THE GRAPHITE–URANIUM DIOXIDE REACTION FROM 1400° TO 1756°C. Lindemer, T. B.; Allen, M. D.; Leitnaker, J. M. (Oak Ridge National Lab., Tenn.). J. Amer. Ceram. Soc., 52: 233-7(May 21, 1969).

The reaction of microspheres of $UO_2$ with graphite was studied from 1400 to 1756°C. When a spherically symmetrical layer of carbide was produced around the $UO_2$ core, only $UC_2$ was formed, and the diffusion of oxygen through this layer was rate-controlling. The Arrhenius relation for this system is $k_D = 21.0 \exp(-90{,}000/RT)$ $cm^2/s$. The reaction of a geometrically nonsymmetrical configuration of $UO_2$ and $UC_2$ was also studied. Comparison of the reactions in the symmetrical and nonsymmetrical systems dem-

onstrated that the kinetic behavior of the two systems is quite different and that the conversion in the nonsymmetrical system was 2 to 5 times faster. The importance of these observations to kinetic results reported in the literature for analogous systems is discussed. (auth)

**30165** ELASTIC CONSTANTS OF POLYCRYSTALLINE BeO AS A FUNCTION OF PRESSURE AND TEMPERATURE. Soga, Naohiro (Rice Univ., Houston, Tex.). J. Amer. Ceram. Soc., 52: 246-9(May 21, 1969).

The sound velocities in polycrystalline BeO and their pressure and temperature derivatives were determined by a pulse superposition method. The derivatives found from the measurements at pressures up to 2 kbars and near 25°C are: $(\partial v_L/\partial P)_T = 6.48 \times 10^{-3}$ km/s kbars, $(\partial v_S/\partial P)_T = 0.33 \times 10^{-3}$ km/s kbars, $(\partial v_L/\partial T)_P = -2.8 \times 10^{-4}$ km/s degree and $(\partial v_S/\partial T)_P = -2.0 \times 10^{-4}$ km/s degree. The very low value of $(\partial v_S/\partial P)_T$ is anomalous for crystalline solids but may be expected from the crystal structure in view of similar anomalous behavior found in other solids with the wurtzite structure. The Grüneisen parameter calculated from the pressure derivatives of sound velocities was small compared with the Grüneisen parameter obtained from thermal properties. This result seems to indicate that the thermal expansivity of BeO does not change with temperature in proportion to the specific heat at low temperatures. (auth)

**30166** X-RAY STRESS ANALYSIS OF WC–Co CERMETS. I. PROCEDURES. French, David N. (Ingersoll–Rand Co., Princeton, N. J.). J. Amer. Ceram. Soc., 52: 267-71(May 21, 1969).

The factors that influence the measurement of stress by a two-exposure x-ray diffractometer technique in the WC phase of WC-Co cermets were studied. Chromium K$\alpha$ radiation was used on the $(10\bar{1}2)$ line of WC ($2\theta = 135.8°$). The x-ray values of Young's modulus and Poisson's ratio are $105 \times 10^6$ psi and 0.19, respectively, and the x-ray stress factor is $1.51 \times 10^8$ psi/Å. The measured stresses are biaxial. Because penetration is limited to less than 5 $\mu$m for CrK$\alpha$ radiation, extreme care in surface preparation and heat treatment is required. A suitable preparation is metallographic polishing with 6 $\mu$m diamond followed by annealing in hydrogen at 750°C. This treatment allows measurement of about 40,000 psi compressive temperature stress inherent in the WC particles resulting from differences in coefficients of thermal expansion between WC and Co. Mechanical stresses can also be measured; they arise from external forces such as grinding, polishing, and sand blasting. Mechanical and temperature stresses cannot always be clearly distinguished, however. (auth)

**30167** X-RAY STRESS ANALYSIS OF WC–Co CERMETS. II. TEMPERATURE STRESSES. French, David N. (Ingersoll–Rand Co., Princeton, N. J.). J. Amer. Ceram. Soc., 52: 271-5 (May 21, 1969).

The effect of cobalt content on the temperature stress in WC-Co cermets was measured using one-exposure and two-exposure x-ray diffraction techniques. In the one-exposure technique, strain is measured by comparing lattice spacings in the stressed, $d_\psi$, and unstressed, $d_0$, conditions. Nonresolution of the $\alpha_1-\alpha_2$ doublet caused by adding Co to annealed WC shifts the apparent peak position to higher diffraction angles (smaller $d_\psi$). The proper choice of $d_\psi$ must be made so that in measuring both $d_0$ and $d_\psi$ similar diffraction peak profiles are used. These conditions have not always been considered, causing part of the previously reported results to be open to question. With the two-exposure technique, no such difficulties exist, because similar peaks are compared at the two angular positions used for measuring d on the same sample. Because of shallow x-ray penetration in WC, only biaxial temperature stresses at the surface are measured. These stresses are compressive, varying from –53,000 psi for WC + 10 vol % Co to –24,300 psi for 37 vol % Co. This trend is in disagreement with previous theories, which predict greater compressive stress as Co content increases. (auth)

**30168** THERMAL EXPANSION OF BeO–SiC COMPOSITES. Rossi, R. C. (Aerospace Corp., El Segundo, Calif.). J. Amer. Ceram. Soc., 52: 290-1(May 21, 1969).

The linear thermal expansion of BeO–SiC composites was measured at room temperature to 1000°C. Hot-pressing was carried out at 1500°C and 4000 psi, to 2000°C and 6000 psi. Examination by electron microscopy revealed a complete network of microcracks in the BeO-matrix composites. The crack network is predominantly planar and defines the specimen orientation relative to the pressing direction during fabrication. During subsequent heating for thermal expansion measurements, the cracks provided accommodation for thermal strain and resulted in lower thermal expansion than that anticipated. Results imply that theories based on simple physical models are inadequate to predict thermal expansion of composites that do not behave as homogeneous materials. (J.C.W.)

**30169** VYSOKOTEMPERATURNOE YADERNOE TOPLIVO. (High-Temperature Nuclear Fuel). Kotel'nikov, R. B.; Bashlykov, S. N.; Kashtanov, A. I.; Men'shikova, T. S. Moscow, Atomizdat, 1969. 368p.

The preparation and uses of nuclear fuels of high-melting U, Th, and Pu compounds are discussed. The radiation resistance of these materials and their compatibility with coolants and construction materials at high temperatures are estimated. New manufacturing methods were analyzed. Properties and phase diagrams for $UO_2$, $PuO_2$, UC, PuC, UN, PuN, UB, PuB, US, and PuS are described. (R.V.J.)

**30170** MEASUREMENT OF THE ELECTRON WORK FUNCTION IN THE SYSTEM ZIRCONIUM–OXYGEN. Nagel, Hartmut; Goretzki, Hans; Mayer, Rolf; Haufler, Gunther (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Z. Metallk., 60: 460-5(May 1969). (In German).

The electron work function in sintered zirconium-oxygen solid solutions between 1600 and 1850°C was determined using the Schottky-Richardson method. The resulting values are strongly dependent on the oxygen concentration. This relation is interpreted as an effect of an increase in Fermi energy in terms of the theory of free electrons in solid metals. The addition of oxygen atoms increases the number of charge carriers in the conduction band in the $\alpha$ as well as in the $\beta$ phase. The results are compatible with measurements of the absolute thermoelectric force. (auth)

**30171** ISOSTATIC HOT-PRESSING: PRACTICAL EXPERIENCE AT AWRE, ALDERMASTON. Long, W. M.; Snowden, P. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Powder Met., 12: 209-18(Spring 1969).

The technique of isostatic hot-pressing and its uses are briefly considered and an account is given of practical experience in the commissioning and operation of an installation of moderate size. The main problems encountered were those of temperature control and uniformity in the furnace in the high-pressure gas; these were overcome by the use of furnaces of special but simple design, which enabled excellent control. The principles of this design are described and some performance figures are cited. (auth) (UK)

**30172** A KINETIC STUDY OF THE OXIDATION OF URANIUM MONOCARBIDE. Ballif III, John Lyman. Salt Lake City, Univ. of Utah, 1968. 118p.
Thesis.

Thin wafers of UC were exposed to oxygen at 400 to 800°C, with partial pressures from 18 to 300 torr, to determine the rate of oxidation. The times of exposure ranged from 1 min to 24 hr. Care was taken during fabrication and storage to prevent exposure of the wafers to water vapor. By means of a calibrated quartz spring balance and a cathetometer, the oxidation kinetics were followed by observing weight changes with time. The oxidation process was characterized by a zero weight change period, a high rate nonisothermal period, and a lower rate isothermal period. The lower rate period occupied 80% or more of the total reaction time. Corrections were applied for area and reaction time. With corrections applied, the data fit equations represented by straight lines or linear kinetics. The oxidation rate was found to be insensitive to the oxygen flow rate; but it was affected by the oxygen partial pressure, in accordance with the relation $(P_{O_2})^{\frac{1}{4}}$. The mechanism can be described as nonisothermal reaction of dry oxygen with the UC surface, forming an oxide layer which quenches the self-heating reaction and returns the reaction temperature to ambient furnace temperature; the molecular oxygen adsorbs on the oxide surface and dissociates on adjacent surface sites to form atomic oxygen; the atomic oxygen diffuses through the oxide layer to form an intermediate activated complex which proceeds to form solid $U_3O_8$ and gaseous $CO_2$ at the interface of the $U_3O_8$ and the UC; a part of the $U_3O_8$ layer is continuously disrupted by stresses from the high specific volume of the $U_3O_8$, which results in linear kinetics. (Disser. Abstr.)

**30173** INFLUENCE OF SPECIMEN GEOMETRY AND STRUCTURE ON THE IMPACT-RESISTANCE OF SILICON CARBIDE. Ashford, J. P.; Priddle, E. K. (Central Electricity Generating Board, Berkeley, Eng.). Powder Met., 12: 169-92(Spring 1969).

Work carried out to determine the impact-resistance of SiC at room temperature and 1000°C is described. Samples were selected for fracture testing according to two criteria: stored energy and Hertzian contact stress. The literature is extensively reviewed for impact-failure mechanisms, but other relevant work on SiC was found to be sparse. Equations are developed that describe the

main impact-resistance criteria, and the influence of microstructure on impact cracking is discussed. (auth) (UK)

**30174** CREEP OF SILICON CARBIDE. Marshall, P.; Jones, R. B. (Central Electricity Generating Board, Berkeley, Eng.). Powder Met., 12: 193-208(Spring 1969).

The creep behaviour of high-density SiC was examined under four-point transverse bending in air at temperatures from 1000 to 1300°C. Stresses in the range 0.207 to 0.496 GN $m^{-2}$ were applied (30,000 to 72,000 psi). In tests lasting up to 3.6 Msec the creep strain ($\epsilon_p$) increased with time (t): $\epsilon_p = At^k$ where k was between 0.2 and 0.5. The dependence of A on stress ($\sigma$) and absolute temperature (T) was found to be $A \propto \sigma^n \exp(-Q/RT)$ with n between 1 and 2, and Q ~ 230 kJ $mole^{-1}$. These results are compared with estimates of creep in SiC obtained by extrapolation of steady-state creep data from higher temperatures. (auth) (UK)

**30175** EFFECTS OF MAGNETIC ORDER ON REFRACTIVE INDEX AND PHOTOCONDUCTIVITY OF EUROPIUM CHALCOGENIDES. Bachmann, R.; Wachter, P. (Eidgenoessische Technische Hochschule, Zurich). J. Appl. Phys., 40: 1326-7 (Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

The refractive index of the europium chalcogenides has been measured as a function of wavelength, temperature, and magnetic field and compared with dispersion theory. Attributing different oscillator strengths to the various substances, classical dispersion theory can account for the observed changes in the refractive index. To get more information about the electronic transitions involved, the spectral photosensitivity of EuO and EuS has been measured as a function of temperature and magnetic field. The results show that in EuO and EuS, electrons are optically excited into a conduction band both above and below $T_c$. Spin-disorder scattering leads to large new magnetophotoelectric effects near the Curie point. (auth)

**30176** ULTRASONIC PROPAGATION IN EuO. Shapira, Y. (Massachusetts Inst. of Tech., Cambridge, Mass.); Reed, T. B. J. Appl. Phys., 40: 1197-8(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

The attenuation of 10- to 90-MHz longitudinal and shear ultrasonic waves propagating along the [100] and [110] directions of EuO single crystals was measured between 63 and 78°K. At zero applied magnetic field, the attenuation was constant above the Curie temperature, $T_c$ = 70°K, but increased as the temperature was lowered through $T_c$. The increase in attenuation was much greater for the shear modes than for the longitudinal modes. Preliminary experiments at $4.2° \leq T \leq 78°K$ with 30-Mhz longitudinal and 10-MHz shear waves propagating along the [100] direction showed that the excess attenuation at $T < T_c$ passes through a maximum near 60°K and is small at 4.2°K. An external magnetic field $H \gtrsim 5$ kG removed the excess attenuation at $T < T_c$. No attenuation peak was found at $T_c$. The excess attenuation at $T < T_c$ is tentatively interpreted as being due to ferromagnetic domains. The elastic constants at 78°K are (in $10^{11}$ cgs units) $c_{11} = 19.2 \pm 0.6$, $c_{44} = 5.42 \pm 0.13$, $c_{12} = 4.25 \pm 0.85$. These lead to an adiabatic bulk modulus $B = (9.2 \pm 0.6) \times 10^{11}$ cgs units, and a Debye temperature $\theta = 350°K$. (auth)

## *Structure and Phase Studies*

*Refer also to abstracts 29960, 30050, 30062, 30063, 30090, 30114, 30115, 30118, 30120, 30150, 30151, 30157, 30173, and 30195.*

**30177** (BMwF-FBK-68-62) NEUTRON DIFFRACTION STUDIES ON BINARY AND TERNARY PHASES OF THE SYSTEMS Ti-C-H, Zr-C-H, Ti-N-H, Zr-N-H, Ti-O-H, AND Zr-O-H. Goretski, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart (West Germany). Institut fuer Sondermetalle). Dec. 1968. 66p. (In German). Dep.

Ordering states were established by neutron diffraction studies in the ternary systems Ti-C-H, Zr-C-H, Ti-N-H, Zr-N-H, Ti-O-H and Zr-O-H which are based on nonstatistical distribution of the metalloid atoms. The structure of the ternary carbohydrides $Ti_2CH_2$ and $Zr_2CH_2$ was determined. The hydrogen atoms occupy the tetrahedral interstitial sites which are farthest from the carbon atoms. In the range of the nonstoichiometric carbides $TiC_{1-x}$ and $ZrC_{1-x}$ fcc ordered phases were found. The nonoccupied octahedral voids are enlarged by distortion of the metal atoms. Additionally soluted hydrogen occupies the free carbon positions. Based on these results the bonding models of the hard metals were discussed and compared with the physical properties of these solids. (auth)

**30178** PHASE EQUILIBRIA IN SOME TERNARY SYSTEMS CONTAINING A TRANSITION METAL OF THE GROUP VA OR VIA SUB-GROUPS WITH SILICON OR BORON. Gladyshevskii, E. I.; Kuz'ma, Yu. B.; Kripyakevich, P. I.; Skolozdra, R. V.; Voroshilov, Yu. V. pp 70-9 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

X-ray and microstructural analyses were used to study the phase equilibria at 800 and 1000°C in ternary alloys of systems containing a transition metal of the VA or VIA sub-groups and B or Si. Alloys containing Si were prepared by electric-arc melting of the pure components under Ar and those containing B by sintering briquettes of the pure materials under vacuum at 1500°C and then remelting under similar conditions. The systems examined were V-Mn-Si, Nb-Co-Si, Nb-Ni-Si, Mo-Fe-Si, Mo-Co-Si, Mo-Ni-Si, W-Ni-Si, Cr-Co-B, Mo-Co-B, and W-Zr-B. All these systems and particularly those containing Si show a large number of ternary compounds and complex phase equilibria. (25 references) (Metals Abstr.)

**30179** A STUDY OF THE PHASE DIAGRAMS AND REACTION OF TITANIUM AND ZIRCONIUM WITH OXYGEN. Model, M. S. pp 164-6 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

An examination of new variations of the Ti-O and Zr-O phase diagrams revealed a non-correspondence between the results of microscopical studies and x-ray data in respect to the existence of a two-phase field in the region between 8 and 20 at. % O in both systems. Dependence of the lattice constant, c, on composition in the Zr-O system with a sharp maximum for the 15 at. % O alloy is doubtful. The nature of the bonding in solid solutions of O in Ti and Zr is considered and the suggestion made that the results should be confirmed by other methods. (auth)

**30180** REPLY TO THE REMARKS OF M. S. MODEL ON A STUDY OF THE PHASE DIAGRAMS AND REACTION OF TITANIUM AND ZIRCONIUM WITH OXYGEN. Glazova, V. V. pp 166-9 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

Neutron-diffraction results, confirming the existence of the suboxides $Ti_3O$, $Ti_6O$, $Zr_3O$, and $Zr_6O$, as shown by x-ray and other physico-chemical methods of analysis, are reported. (Metals Abstr.)

**30181** TERNARY SYSTEMS OF RHENIUM WITH TRANSITION REFRACTORY METALS AND CARBON. Kuz'ma, Yu. B.; Gladyshevskii, E. I.; Gorshkova, L. V. pp 185-91 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

X-ray and microstructural analytical methods were used to construct isothermal sections of the ternary systems Hf-Re-C at 1500°C and Nb-Re-C and Ta-Re-C at 1800°C. Related types of phase equilibria were found in all three systems. The limited solid solutions of Re in the monocarbides of Hf, Nb, and Ta were found in equilibrium with the solid solutions based on the components and intermediate phases of the binary Re-Hf (Nb, Ta) systems. Solid solutions based on the sub-carbides and $\xi$-phase of Nb and Ta were found in equilibrium with the Nb- and Ta-base solid solutions, respectively. In the cast alloys, the systems studied each had a ternary phase in the Re-rich region. (Metals Abstr.)

**30182** A STUDY OF THE PHASE DIAGRAMS AND REACTION OF TITANIUM AND ZIRCONIUM WITH OXYGEN. Kornilov, I. I.; Glazova, V. V.; Kenina, E. M. pp 145-53 of Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

A study was made of the suboxides in the systems Ti-O and Zr-O by physico-chemical analysis. Suboxides of the types $Me_6O$ and $Me_3O$ were found to exist. The bonding of the Ti suboxides is metallic and that of the Zr suboxides primarily covalent. A study of the Ti-Zr-O system along the $Ti_3O$ and $Zr_3O$ section showed this to be quasi-binary. $Ti_3O$ and $Zr_3O$ react to give a phase diagram of eutectic type with limited solubility in the solid state. (Metals Abstr.)

**30183** INVESTIGATION OF PHASE EQUILIBRIA AND CRYSTAL STRUCTURE OF COMPOUNDS IN THE SYSTEM Ti-Fe(Co,Ni)-Si. Markiv, V. Ya.; Gladyshevskii, E. I.; Kripyakevich, P. I.; Fedoruk, T. I.; Lysenko, L. A. pp 137-44 of

Diagrammy Sostoyaniya Metallicheskikh Sistem. Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1968. (In Russian).

X-ray and microstructural analyses were used to study the phase equilibria at 800 and 750°C in the Ti–Ni–Si system and the partial crystal structure of the ternary compounds in the Ti–Fe–Si, Ti–Co–Si, and Ti–Ni–Si systems. These systems have a large number of compounds. The existence of seven known ternary compounds was confirmed and eleven new ones found. In terms of crystal structure the Ti–Co–Si and Ti–Ni–Si systems were very similar (but differ appreciably from that of Ti–Fe–Si). In these two systems ternary compounds are formed with structure types $MgZn_2$, $Mg_6Cu_{16}Si_7$, TiNiSi, $TiNiSi_2$, and $T_3$ phase. In the Ti–Fe–Si system, however, compounds are formed with $TiFeSi_2$ and TiFeSi compositions with rhombic and hexagonal structures of new unknown types. The formation of isostructural hexagonal $T_3$ phases is common to all three Ti–Fe(Co, Ni)–Si systems. (29 references) (Metals Abstr.)

**30184** DISLOCATION SUBSTRUCTURES IN DEFORMED URANIUM DIOXIDE SINGLE CRYSTALS. Yust, C. S.; McHargue, C. J. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 31: 121-37(June 1969).

Single crystals of uranium dioxide were deformed in compression to nominal strains of 1 and 5%. The crystals were oriented to promote slip on only one slip system of the family {100} ⟨110⟩. The strain rate and temperature ranges studied were $10^{-3}$ to $10^{-1}$ min and 750 to 1400°C, respectively. The dislocation density of the as-grown crystals was $2 \times 10^6/cm^2$. Sections of the deformed specimens were examined by transmission electron microscopy, indicating that the dislocation substructures at a strain of 1% consist of numerous dipoles and dipole loops, the edge components of the dipoles lying along ⟨110⟩ directions. At 5% strain, extensive dislocation tangles are present in addition to the dipole configurations. The critical resolved shear stress on the {100} ⟨110⟩ slip system is reported as a function of temperature, as is the variation in the appearance of the load-deflection curve with temperature level. Of particular interest is the markedly serrated load-deflection behavior observed at 1150°C, and the minimum in the shear stress curve at 950°C. The dislocation density as a function of strain has been evaluated, and dislocation velocities are estimated. (auth)

**30185** STRUCTURAL TRANSFORMATIONS IN $U_3Si$. Bethune, B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 31: 197-202(June 1969).

X-ray diffraction analysis has been used to examine the phase change introduced in $U_3Si$ thermally, by irradiation at 60°C, and by plastic deformation. Short irradiation exposures (burnup $\leq 0.12 \times 10^{-3}$% of all atoms) and plastic deformation modified the room temperature structure of $U_3Si$, bc tetragonal, to a disordered fcc structure, while heating above 756 ± 5°C caused an allotropic transformation to an ordered fcc structure of the $Cu_3Au$ type. Lattice parameter determinations indicated that the irradiation-induced phase transformation was accompanied by a volume increase of 0.6%. Further irradiation resulted in a nearly complete destruction of the diffraction pattern as the $U_3Si$ became amorphous. The damage introduced by irradiation or by plastic deformation annealed in the range 250 to 500°C with a complete recovery to the bc tetragonal structure. (auth)

**30186** $UO_2$-CERMETS WITH IDEALIZED STRUCTURE BY PARTICLE COATING AND ISOSTATIC HOT PRESSING. Weimar, P.; Thuemmler, F.; Bumm, H. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater., 31: 215-25(June 1969).

The process of isostatic hot pressing is not very widely used. It is described for the production of clad and unclad cermets in the uranium dioxide–molybdenum system. Coated particles were used as the starting material. Impact and bending strengths were determined on polished test pieces at room temperature in relation to porosity and metal content. Electrical and thermal conductivity were measured as a function of the molybdenum content. Within certain compositional ranges, property values obtained were superior to those for cermets made from mixed powders. Using a correction factor for porosity and a statistical approach, thermal conductivity values for isostatically hot pressed coated powders are shown to be higher than those for powder mixtures. (auth)

**30187** INFRARED SPECTRA OF THORIA GELS. Hardy, C. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 71-7 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

The infrared spectra of thin films of thorium nitrate and thoria gels derived from thorium nitrate by precipitation and by thermal denitration were measured on silver chloride plates. This technique gave good quality spectra and avoided the use of mulling agents with interfering absorption bands in the 2 to 15 μm region, or alkali halide discs in which rearrangement reactions with nitrate groups are known to occur. The nitrate was present as coordinated nitrate groups in the gels prepared by both methods and containing a range of nitrate-to-thorium mole ratios of 0.02 to 0.3. Small amounts of residual nitrate, and the solid state reaction of this with potassium bromide, have been overlooked in previous interpretations of the spectra and structure of thorium hydroxide precipitates derived from thorium nitrate. (auth)

**30188** EXAMINATION OF SOL-GEL $UO_2$ SURFACES BY SCANNING ELECTRON MICROSCOPY. Hardy, C. J.; Hannam, M. J.; Lyon, C. E.; Jackson, C. K. (Atomic Energy Research Establishment, Harwell, Eng.). pp 61-9 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

Scanning electron microscopy has many advantages over optical microscopy and transmission electron microscopy for the study of bulk samples. The external and fracture surfaces of 500-μm diameter spheres of dense and porous sol-gel $UO_2$ have been examined with this new technique at magnifications up to 9200 without the need for lengthy sample preparation. The results are compared with those from optical micrographs of polished and etched sections. Spheres of $UO_2$ of 89 and 96% density calcined for 4 hr at 1150°C in hydrogen had a smaller grainsize (0.2–0.4 μm) in the surface layers than in the bulk (0.6 μm); closed pores of the order of 0.1 μm diameter were present on the grain boundaries. Spheres of $UO_2$ of 500 μm diameter and greater than 98% density calcined for 4 hr at 1400°C in hydrogen had a surface layer of 30 μm depth containing grains of about 1 μm mean size, with larger grains (3 μm) in the bulk. A possible explanation of these observations is grain growth inhibition in the surface layers by impurities, which may be metallic oxides or particles of carbon arising from the decomposition of organic material used in the preparation of the gel spheres or gaseous impurities trapped in small closed pores. (auth)

**30189** THRESHOLD EFFECTS IN THE CHARACTERISATION OF PERFECTION OF GRAPHITE. Ubbelohde, A. R. (Imperial Coll. of Science and Tech., London). J. Chim. Phys., Special No., 64-70(Apr. 1969).

From 18th Annual Meeting on Carbonization and Graphitization, Paris, France. See CONF-680620.

Compared with many other solids, carbons and graphites can incorporate an unusually large diversity of crystal defects. This is due to highly versatile chemical bond formation by carbon atoms. Physical methods for defect characterization are well known, but have limitations. Descriptions and discussions are presented on methods for defect characterization which depend on chemical measurements, using thresholds in chemical or electrochemical potential for intercalation. (auth)

**30190** THE VARIATION OF LATTICE PARAMETER WITH CARBON CONTENT OF TaC–WC SOLID SOLUTION IN HIGH CARBON RANGE. Hachisuka, Takeji (Fujikoshi, Ltd., Toyama, Japan). Funtai Oyobi Funmatsuyakin, 16: 38-41(Mar. 1969). (In Japanese).

Tantalum carbide–tungsten carbide solid solutions in high carbon range, containing up to 30 mole % WC, were prepared by heating single carbide mixtures in vacuum. The variations of lattice parameter with carbon content were studied. The lattice parameter of TaC–WC solid solutions increased linearly with carbon content. Fitted equations of these solid solutions were obtained by applying the least-squares as follows. $(Ta_{0.9}W_{0.1})C$: $a_0 = 4.337 + 0.101\ X$, $(Ta_{0.8}W_{0.2})C$: $a_0 = 4.311 + 0.116\ X$, $(Ta_{0.7}W_{0.3})C$: $a_0 = 4.328 + 0.085\ X$, $X = C/(Ta + W)$. The slopes of these equations are smaller than that of TaC obtained by other investigators. However, the recalculated value of the slope employing Bowman's results in high carbon range agreed with the values of solid solutions within the range of experimental errors. (auth)

**30191** MAGNETIC PHASE DIAGRAM OF THE $UP_{1-x}S_x$ SYSTEM. Kuznietz, Moshe; Lander, G. H.; Baskin, Y. (Argonne National Lab., Ill.). J. Appl. Phys., 40: 1130-1(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

The magnetic phase diagram of the $UP_{1-x}S_x$ system ($0 \leq x \leq 1$) was investigated in a temperature range from 5 to 300°K by neutron diffraction with powder samples. The types of ordering, ordered moments, and the temperature dependence were determined. The crystal structure of the solid solutions is fcc (NaCl-

type). As x increases, three types of magnetic ordering are observed: Antiferromagnetic (AF) type-I, AF type-IA, and ferromagnetic. The type-IA ordering consists of ferromagnetic sheets as in type-I, but whereas in the latter the sheets are arranged +−+−..., they are now stacked ++−−.... For x = 0 (UP) and 0.02 the order is AF-I. For $0.05 \leq x \leq 0.10$, the AF-I structure is present at high temperatures but a transition to AF-IA occurs at low temperatures. The temperature of this transition increases with x. For x = 0.15 and 0.20, the magnetic structure is AF-IA. The samples with x = 0.25 and 0.28 are initially ferromagnetic, but at low temperatures a transition to the AF-IA structure occurs. An intermediate structure probably involving a complicated spin arrangement is also present for x = 0.25 before the AF-IA structure is established. For $x \geq 0.33$, the ordering is ferromagnetic. (auth)

### *Radiation Effects*

*Refer also to abstracts 31166 and 31167.*

**30192** SOL-GEL PROCESSES IN THE DRAGON PROJECT: A SUMMARY OF WORK. Price, M. S. T. (Atomic Energy Establishment, Winfrith, Eng.). pp 119-29 of Sol-Gel Processes for Ceramic Nuclear Fuels. Vienna, International Atomic Energy Agency, 1968.

From Panel on Sol-Gel Processes, Vienna, Austria. See STI/PUB-207; CONF-680532.

A high-temperature gas-cooled reactor uses fuel in the form of microspheres coated with pyrolytic carbon and silicon carbide. Although development work on the fabrication of fuel kernels by the Dragon Project has concentrated on powder agglomeration methods, the perfection of the spheres formed by sol-gel processes is obviously attractive for kernel fabrication. In this way the coating laid around the spheres can have optimum mechanical properties. By suitable choice of sol-gel process, the wide range of carbide and oxide compositions called for by the Dragon Project irradiation program can be made in sizes up to 700 μm after sintering. Difficulties were only experienced with low thorium/uranium ratios—outside the range of practical interest for power reactors. Initial experience with plutonium fuels has also been obtained. Irradiation experiments in the Dragon Reactor which are based on sol-gel process kernels are summarized. A detailed study of the cost of reprocessing thorium cycle HTR fuels has been commissioned by the Dragon Project and probable costs are given for a plant processing 30 tonnes of heavy metal/yr. (auth)

**30193** DISSOLUTION OF UC PARTICLES IN URANIUM DURING POSTIRRADIATION ANNEALING. Kulcinski, G. L.; Leggett, R. D. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Trans. Met. Soc. AIME, 245: 929-33(May 1969).

Irradiated uranium containing 635 ppM of carbon, mostly in the form of UC precipitates, was annealed at 650 to 900°C under hydrostatic pressures of 0 to 1000 bars. Examination revealed that the carbide particles are not stable in the γ phase of irradiated material but are stable in unirradiated material annealed under identical conditions. The degree of carbide dissolution appears to be connected with the fission product concentration and independent of annealing pressure. (auth)

**30194** PROCESS OF DEGRAPHITIZATION UNDER THE EFFECT OF NEUTRON RADIATION. Micaud, Georges (CEA, Saclay, France); Rappeneau, Jean; Pacault, Adolphe; Marchand, Andre; Amiell, Jacques. J. Chim. Phys., Special No., 129-39 (Apr. 1969). (In French).

From 18th Annual Meeting on Carbonization and Graphitization, Paris, France. See CONF-680620.

The effects of neutrons on the electric and magnetic properties of a polycrystalline nuclear graphite were studied at doses increasing to $8.5 \times 10^{21}$ neutrons/cm$^2$ and at 85, 150, 200, and 280°C. The electric resistivity, Hall effect, magneto-resistance, magnetic susceptibility, and electronic paramagnetic resonance of these samples were measured at 300°K to correlate the variation of the properties with dose at different temperatures. Certain of these samples, irradiated under different dose and temperature conditions, were heat-treated and examined in the course of annealing. The analogy between the curves thus obtained and those plotted during graphitization of the same material suggests that the effect of neutron radiations may resemble a degraphitization process. (tr-auth)

**30195** YOUNG'S MODULUS OF PYROLYTIC GRAPHITE. Knibbs, R. H. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon, 7: 225-8(Apr. 1969).

The Young's modulus of pyrolytic graphite with varying degrees of preferred orientation was measured by the flexural vibration technique. The results were compared with values predicted by means of single crystal elastic constants. The effect of neutron irradiation on the material in its various stages of crystal alignment lends strong support to the applicability of the uniform stress model to graphite. (auth) (UK)

**30196** GRAPHITE IRRADIATIONS 300° TO 1200°C. Cox, J. H. Jr.; Helm, J. W. (Battelle-Northwest, Richland, Wash.). Carbon, 7: 319-27(Apr. 1969).

Irradiations of a large variety of graphites were conducted at temperatures from 300−1200°C to maximum neutron fluences of $2.7 \times 10^{22}$ nvt (E > 0.18 MeV). As temperatures and neutron fluences increased, bulk expansion of the graphite became the controlling behavior in all orientations. Materials which were well graphitized, highly crystalline, isotropic, and had a high coefficient of thermal expansion, showed the lowest contraction at moderate fluences. The dimensional-change data for all graphite types could be separated into two bands. The first band represented data for samples irradiated in the temperature range 300−800°C and the second, which showed a highly accelerated damage rate, represented data for samples irradiated at 900−1200°C. The transition from the lower damage rate to the higher rate took place over a narrow temperature range (~800−900°C). Within each band the data were grouped closely. These observations, based on relatively small samples, generally <0.5 in. dia by <4 in. length may not exactly represent the behavior of larger pieces. However, expansion will probably be the ultimate controlling behavior in the larger sizes also. (auth) (UK)

**30197** ALTERATION OF CLAY MINERALS BY ELECTRON IRRADIATION. Chute, J. H.; Armitage, T. M. (Univ. of Western Australia, Nedlands). Clay Miner., 7: 455-7(Dec. 1968).

In an electron microscope study of clay and accessory minerals, structural changes resulting from electron beam irradiation were observed. After a few minutes exposure to a high intensity electron beam (10 to 20 mA at 75 kV), many irregular voids were formed in crystals of kaolinite, halloysite, dickite, and talc. At the same time a pronounced rim developed around the edges of the crystals, and there was a loss of crystallinity as shown by selected area electron diffraction patterns taken before and after irradiation. For pyrophyllite the loss of crystallinity was observed; however, no voids were formed. Several different illites were irradiated and, with 2 exceptions, voids were produced in these, but with more difficulty than in the kaolins. For the accessory minerals goethite and gibbsite similar results were obtained; however, in gibbsite, depending on the external morphology of the crystal, the voids were occasionally of a crystallographic shape. During electron beam irradiation, damage may be produced either by atomic displacements resulting from collisions with bombarding electrons, or the damage may result from thermal changes produced by the heating effect of the electron beam. In these clay minerals no atomic displacement effects, e.g., defect clusters or dislocation loops, were observed, and it is believed that the voids are formed by high pressure gas accumulation resulting from thermal dehydroxylation of the crystals. (BBB)

## Plastics and Other Materials

*Refer also to abstracts 29955, 29958, 30626, and 31209.*

**30198** (AEEW-M-831) THERMAL DECOMPOSITION OF A LOW-VISCOSITY EPOXY RESIN. Fortescue, W. F.; Overend, R. P.; Redding, G. B. (Atomic Energy Establishment, Winfrith (England)). July 1968. 17p. Dep. CFSTI. UK.

In order to assess the consequences of overheating an experimental reactor fuel plate containing a low viscosity epoxy resin (Araldite), the thermal decomposition of this material was studied with respect to the kinetics and gas evolution. The decomposition occurred as a series of reactions, the major two reactions being first order with high activation energies. The maximum prolonged temperature was 260°C; at 300°C the half life of decomposition was approximately 3 hours, and only 0.1 second at 500°C. The quantity of gas evolved was ≃20 cm$^3$ (stp) gram$^{-1}$ at 500°C and consisted of carbon dioxide, carbon monoxide, and small organic molecules. (auth) (UK)

**30199** (N-69-10066) A STUDY TO DETERMINE THE PRESENCE OF VOLTAGE BREAKDOWN DUE TO PROTON IRRADIATION IN POLYMERIC MATERIALS. Hendricks, Herbert D.; Miller, William E. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Nov. 1968. 21p. (NASA-TM-X-1688). CFSTI.

A study was made to determine proton induced voltage breakdowns in a series of polymeric materials: Kapton (H-film), Teflon (TFE), Pyrrone, Mylar, and polyethylene. Proton energy was

varied from 0.40 to 3.25 MeV with a flux of $10^9$, $10^{10}$, $10^{11}$, or $2 \times 10^{11}$ protons/cm$^2$-sec. Samples at 27 and −134°C were irradiated to a flux of $10^{13}$ to $5 \times 10^{14}$ protons/cm$^2$ for each test. No charge storage or induced voltage breakdown effects were observed. This observation is in sharp contrast to the numerous induced voltage breakdowns observed for electron irradiation of similar types of polymeric samples. A theory developed by Nichols and van Lint predicts that a behavior of this type should be less prevalent because of proton rather than electron irradiation. (Metals Abstr.)

**30200** (RAE-TR-68218) MASS SPECTROMETER ANALYSIS AND TENSILE TESTING OF IRRADIATED MATERIALS FOR SATELLITE APPLICATIONS. Williams, T. N. (Royal Aircraft Establishment, Farnborough (England)). Aug. 1968. 20p. Dep.

Three types of sheet plastic material and a quantity of "Loctite" sealant, intended for use in satellites, were given an overdose of gamma irradiation while under vacuum. The quantity of outgassing was measured and the gas composition analyzed using a mass spectrometer. The tensile strength of the plastic materials was also tested both before and after irradiation. The materials examined were EVA (a copolymer of ethylene and vinyl acetate), "Minicel" (foamed crosslinked EVA), and foamed crosslinked low density polyethylene. (auth) (UK)

# PHYSICS (GENERAL)

## Astrophysics and Cosmology

**30201** (CONF-680650) PAPERS PRESENTED AT THE NORDIC ASTRONOMICAL MEETING IN OSLO, JUNE 15–16, 1968. Report No. 28. (Oslo Univ. (Norway). Institutt for Teoretisk Astrofysikk). 49p. Dep.

This report contains the contributions given at the Oslo meeting of astronomers from Denmark, Finland, Norway, and Sweden. They cover many aspects of astronomical research and give an impression of the scope of the astronomical activities in these countries. It contains English translations either of the brief unabridged papers or abstracts. (W.D.M.)

### Cosmic Ray Exposure Ages

**30202** ELEMENTS 112 TO 119: WERE THEY PRESENT IN METEORITES? Anders, Edward (Univ. of Chicago); Heymann, Dieter. Science, 164: 821–3(May 16, 1969).

Chondrites contain a small fission xenon component of unexplained origin. Evidence on the geochemical behavior of this component suggests that it was not derived from an actinide element (Z = 89 to 103), or from a transition metal between Z = 104 and 111, but from a more volatile progenitor. The most likely candidates are the superheavy elements between Z = 112 and 119, whose lighter congeners (mercury, tellurium, lead, and the like) are known to be strongly fractionated in meteorites. (auth)

**30203** FISSIOGENIC AND RADIOGENIC XENON IN THE CHONDRITES BEARDSLEY AND HOLBROOK. Reynolds, M. A.; Rao, M. N.; Meason, J. L.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). J. Geophys. Res., 74: 2711–16(May 15, 1969).

The amounts of excess fissiogenic xenon ($^{136}$fXe) and excess radiogenic xenon ($^{129}$rXe) in the chondrites Beardsley and Holbrook have been measured to be $^{136}$fXe = 0.7 ± 0.3 and 0.7 ± 0.3, $^{129}$rXe = 2.0 ± 0.8, and 13.2 ± 2.9, respectively, in the unit of $10^{-12}$ cc STP/g. If $^{136}$fXe and $^{129}$rXe are the decay products of extinct radionuclides $^{244}$Pu and $^{129}$I, respectively, produced in the galactic nucleosynthesis process, the Pu/Xe and I/Xe decay intervals for both these chondrites can be shown to be concordant at approximately 200 m.y. (auth)

### Stars

*Refer also to abstracts 30275 and 30819.*

**30204** STUDY OF A THREE-DIMENSIONAL REPRESENTATION OF STARS OF THE SPECTRAL TYPE BETWEEN $A_0$ AND $G_5$. Hauck, B. (Observatoire de Geneva). Arch. Sci. (Geneva), 21: 133–64(May-Aug. 1968). (In French).

A 3-dimensional representation was established for stars of spectral type between $A_0$ and $G_5$ and of luminosity class V and IV. The effects of blanketing could thus be made conspicuous and calculated for the indexes of color and the parameter used. Application of this system to the Am stars showed that they can be included in a $M_v/B_2-V_1$ diagram in a zone of one magnitude, situated above a sequence of reference, the most possible sequence approaching age zero. Furthermore there was a correlation between the metallic character and velocity of rotation of the star. In this representation, the subdwarfs are situated among the dwarfs deficient in metals, that is, with a low value of Fe/H. It was also possible to distinguish giant stars of population II and stars of horizontal branch in the H–R diagram. (BBB)

**30205** SELF-GRAVITATIONAL SYSTEMS AT CONSTANT PHASE DENSITY IN A FINITE DOMAIN. Bouvier, P. Arch. Sci. (Geneva), 21: 175–88(May-Aug. 1968). (In French).

In a stellar system, for any given conditions, a self-gravitating system undergoes at first a short phase of violent relaxation due to collective effects, followed over a much longer span of time by relaxation due to binary collisions between stars of the system. The possible state of equilibrium after the violent relaxation stage is considered. This problem is discussed for 2- and 3-dimensional systems on lines similar to those followed by Hohl & Feix for the 1-dimensional case using the so-called waterbag model. The system cannot reach a state of equilibrium by violent relaxation alone; numerical computations performed by several earlier authors are completed for the 3-dimensional problem, showing that the system tends to approach equilibrium. (BBB)

**30206** NUMERICAL STUDIES OF STAR SYSTEMS. Ulam, S. (Los Alamos Scientific Lab., N. Mex.). Bull. Astron., 3: 265–7(1968).

Experiments performed on electronic computing machines dealt with a system of 32 and more (up to 50) stars. As an initial condition, a quasi-equilibrium configuration satisfying the virial theorem was assumed. All the stars were positioned in a sphere whose radius was equal to 5, in some problems, or to 10 in some other problems. The motion of this system, under Newtonian attraction, was followed in short time steps to study the process of collision. Collisions were defined by assuming that whenever any two stars touch they remain together and the combined mass moves so as to preserve the momentum but, of course, not the energy which they had before the collision. The problem of whether the process of collision accelerates after some initial ones have taken place was examined. The data support this conjecture. The collisions occur in spurts. Also examined was the final state of the system. In most cases (80%) the system coalesced to one large mass with a few smaller ones remaining around it. In the remaining cases there was 1 very large mass together with another sizable one and 1 or 2 original stars around it. In most cases an escape of one or more stars was observed, mostly only a few, from the original system. A quantitative measure of flattening of the system which originally was assumed was introduced, to have a spherical symmetry in positions and isotropy in velocities. The measure of flattening seemed to increase steadily in most of the problems. Another way of interpreting the collisions is considered. Assuming a large and very tenuous mass of gas endowed with turbulent motion and gravitating, stars may be considered as representing the centers of mass of large portions of the gas. The problem was to determine whether this mass will contract to a single large object or to a binary or multiple system. Hydrodynamical calculations based on the idea of representing positions of the fluid by centers of mass of large parts of it were performed. (BBB)

**30207** COLLECTIVE MOTIONS IN A SPHERICAL STAR CLUSTER. Henon, Michel (Institut d'Astrophysique, Paris). Bull. Astron., 3: 241–64(1968).

The initial dynamic evolution of a stellar system, when collective motions dominate and the effect of encounters can be neglected, is studied by Campbell's numerical technique of concentric spherical shells. Results showed that the final steady state is in good agreement with Lynden–Bell's theory in the central parts, but not in the outer parts. The evolution is quite sensitive to small fluctuations in the initial distribution. In some cases, the radial oscillations of the system seem to continue indefinitely. Tentative explanations are offered for these phenomena. (auth)

**30208** EVOLUTION OF CLOSE BINARIES. III. CASE A OF MASS EXCHANGE FOR STARS OF 5 SOLAR MASSES. Plavec, M.; Kriz, S.; Horn, J. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 20: 41–61(1969).

Mass exchange in close binary systems of very short period (around one day) and of moderate total mass transforms detached main-sequence systems into semidetached binaries in which the less massive component is a moderately overluminous subgiant. Examples of such systems are u Her, U Sge, or Z Vul. The process was studied in systems with the same initial mass of the more massive component, namely 5 $M_\odot$. It is shown that the outcome depends considerably on the initial mass of the secondary component, and on the age (degree of chemical inhomogeneity in the interior) of the primary component. The process of mass exchange consists of two phases, rapid and slow. The outcome of the rapid phase can be found with sufficient approximations by the method of stationary models. More evolved primaries produce subgiants (or giants) of higher overluminosity. The amount of material transferred is larger for lower initial mass ratios. With evolved primaries and small secondaries, more than 70% of the initial mass of the primary is transferred. In any case, the roles of the components are interchanged by mass exchange. As a rule, the orbital period and difference in the masses of the components are increased. The phase of rapid mass exchange is relatively very short, as a rule shorter than $10^6$ yr, and chances to catch a system at this stage are low. The phase of slow mass loss has a duration of the order of $10^7$ yr and corresponds to the phase at which the semidetached Algol-like binaries mentioned above are observed. The change in the elements of the binary, and in the characteristics of the stars in the course of this stage, are perceptible. This phase ends when either the primary detaches itself from the Roche limit or the secondary (now the more massive star) expands to its Roche limit. Eight examples were computed by means of the modified Henyey method. It is seen that almost each case has its specific features, and extensive series of nonstationary models are necessary, which makes the task of comparison with observed systems difficult. (auth)

**30209** RADIOACTIVE LIGHT-SOURCES IN PHOTOELECTRIC PHOTOMETRY. Tremko, J. (Astronomical Inst., Skalnate Pleso, Czech.). Bull. Astron. Inst. Czech., 20: 81-3 (1969).

The characteristics of radioactive light-sources were studied with a view of using such sources in photoelectric photometry. Short-lived brightness variations, in intervals of $10^2$ seconds, reach, for two radioactive light-sources, from 0.0032m to 0.0034m; the systematic differences in the brightness of two specimens reach from 0.0010m to 0.0018m during $10^4$ to $10^5$ seconds. The spectrum of the $\gamma$ radiation of radioactive light-sources corresponds to uranium and its decay products. (auth)

**30210** PHASE DENSITY OF WHITE DWARFS IN THE COLOR-LUMINOSITY DIAGRAM. Eigenson, A. M. (Astronomical Observatory, Lvov). Astrophysics (Engl. Transl.), 3: 54-6 (Spring 1967).

Translated from Astrofizika, 3: 103-10(1967).

The usual assumptions with regard to the structure of white dwarfs are used to derive a formula for their phase density in the color–luminosity diagram. Comparison with observations suggests that the model employed in the calculations is valid. (auth)

**30211** PHOTOMETRIC AND COLORIMETRIC CHARACTERISTICS OF ERUPTIVE STARS. IV. Gershberg, R. E. (Astrophysical Observatory, Crimea, USSR). Astrophysics (Engl. Transl.), 3: 64-6(Spring 1967).

Translated from Astrofizika, 3: 127-32(1967).

The theoretical colors (U – B, B – V) of a hot gas, which is optically thin in the continuous spectrum and has an optical thickness of several units in the lines of the Balmer series, are evaluated. The colors of the additional emission arising during flares of UV Ceti stars fall in a region corresponding to this gas on the two-color diagram. (auth)

**30212** OBSERVATIONAL SELECTION AND STATISTICS OF VISUAL BINARY SYSTEMS. II. STATISTICS. Fesenko, B. I. Astrophysics (Engl. Transl.), 3: 57-63(Spring 1967).

Translated from Astrofizika, 3: 111-26(1967).

This paper presents statistical data, with observational selection taken into account, for 412 visual binary systems with known spectral classes or colors for the two components, one of the components of each system being near the main sequence. (auth)

**30213** A SUPERNOVA IN NGC 2276. Iskudaryan, S. G.; Shakhbazyan, R. K. (Astrophysics Observatory, Byurakan, USSR). Astrophysics (Engl. Transl.), 3: 67(Spring 1967).

Translated from Astrofizika, 3: 133-5(1967).

A stellar object was found in NGC 2276 on plates obtained in 1962 with the 21-inch Schmidt telescope at the Byurakan Observatory. The reasons for presuming this a supernova are given. (W.D.M.)

**30214** STUDY BY MASS SPECTROMETRY OF THE PRODUCTION OF ISOTOPES OF LITHIUM, BERYLLIUM, AND BORON IN TARGETS OF OXYGEN AND CARBON IRRADIATED BY HIGH-ENERGY PROTONS. INCIDENCES ON THE PROBLEM OF THE PROPAGATION OF COSMIC RAYS AND THE NUCLEOSYNTHESIS OF LIGHT ELEMENTS. Yiou, Francoise. Ann. Phys. (Paris), 3: 169-209(May-June 1968). (In French).

A "pulverized-cathode" ion source was adapted to a classical mass spectrometer. This permitted the determination of microtraces lower than $10^{-10}$ g. The spallation production rates of $^{6}$Li, $^{7}$Li, $^{7}$Be, $^{9}$Be, $^{10}$Be, $^{10}$B, and $^{11}$B in targets of $^{16}$O and $^{12}$C were measured, and the results are tabulated. These experimental data made it possible to add to the knowledge of spallation reactions of light nuclei. Their application in astrophysics gave quantitative results on the nucleosynthesis of Li, Be, and B in the solar system and the stars, and on the propagation of the nuclear component of the galactic cosmic radiation. The spallation origin of the light elements in the solar system, the surface of the stars, and the cosmic radiation was confirmed by the results obtained. The stability of $^{7}$Be in cosmic radiation was shown for the first time. (tr-auth)

**30215** MONOCHROMATIC REFLECTION EFFECT IN CLOSE BINARY SYSTEMS. Pustyl'nik, I. B. (Inst. of Physics and Astronomy, Tartu). Astrophysics (Engl. Transl.), 3: 39-45 (Spring 1967).

Translated from Astrofizika, 3: 69-83(1967).

It is postulated that allowance for the nongrayness of the matter of a reflecting star and gravitational darkening could explain the negative O–C amplitudes of the reflection effect in close binaries. The Chandrasekhar method is used to solve the transfer equation for a plane-parallel layer in a state of local thermodynamic equilibrium and with an absorption coefficient weakly dependent on $\lambda$ ($H^-$ ions) and illuminated by a point source. The solution is used to determine the monochromatic amplitude of the reflection effect. The reflecting surface is identified with the critical Roche surface. (auth)

**30216** INFLUENCE OF PERIODIC SHOCK WAVES ON THE DENSITY DISTRIBUTION IN THE ATMOSPHERE OF A PULSATING STAR. Klimishin, I. A. (Astronomical Observatory, Lvov). Astrophysics (Engl. Transl.), 3: 121-3(Summer 1967).

Translated from Astrofizika, 3: 259-65(1967).

An approximate expression is obtained for the density distribution established in the atmosphere of a star under the action of periodic shock waves. It is found that the scale height is directly proportional to the square of the Mach number characterizing the intensity of the shock wave. (auth)

**30217** INTERPRETATION OF THE POLARIZATION VARIABILITY OF $\beta$ LYRAE RADIATION. Shulov, O. S. (Leningrad State Univ.). Astrophysics (Engl. Transl.), 3: 111-15(Summer 1967).

Translated from Astrofizika, 3: 233-44(1967).

It is shown that the variable component of the polarization of $\beta$ Lyrae is due to scattering of radiation from both the primary star and the companion by free electrons in the gas disk associated with the companion (Su-Shu Huang's model of the $\beta$ Lyrae system). The electron concentration, the total number of free electrons, and the mass were found for the gas disk. The model obtained for the $\beta$ Lyrae system is shown. (auth)

**30218** EFFECTS OF GAS STREAMS IN CLOSE BINARY SYSTEMS. Gorbatskii, V. G. (Leningrad State Univ.). Astrophysics (Engl. Transl.), 3: 116-20(Summer 1967).

Translated from Astrofizika, 3: 245-57(1967).

Effects produced by a gas stream in the envelope of a star in a close binary system are considered. Estimates are made of the energy transferred by the stream, the temperature of the envelope layer heated during collision, and the coding time for this layer. Some observed features of the light curves and the spectra of VV Pup, U Gem, and UX UMa can be explained on this basis. (auth)

**30219** SPECTROSCOPIC INVESTIGATION OF $\epsilon$ AURIGAE. Ivanova, N. L. (Astrophysical Observatory, Byurakan, USSR). Astrophysics (Engl. Transl.), 3: 107-10(Summer 1967).

Translated from Astrofizika, 3: 233-31(1967).

Thirty-three spectrograms of the eclipsing binary $\epsilon$ Aurigae, obtained with the 10-inch ASI-5 telescope during the 1955–1957 minimum and outside this period, were investigated spectrophotometrically. The physical conditions in the atmospheres of $\epsilon$ Aurigae and the F5 supergiants $\alpha$ and $\nu$ Persei are compared. Analysis of the spectrophotometric results indicates that the main component of the system has an extensive nonstationary atmosphere, and that the depth of the eclipse is wavelength-dependent in the ultraviolet region of the spectrum. (auth)

**30220** DETERMINATION OF THE TEMPERATURE OF STARS SURROUNDED BY EXTENDED GAS ENVELOPES OR NEBULAS. Boyarchuk, A. A. (Astrophysical Observatroy, Crimea, USSR). Astrophysics (Engl. Transl.), 3: 96-8(Summer 1967).

Translated from Astrofizika, 3: 203-8(1967).

A method is proposed for the determination of stellar temperatures from the relative intensities of the continuous stellar and nebular spectra. The method was used to determine the temperatures of Be stars and the hot components of symbiotic stars. (auth)

**30221** EQUILIBRIUM OF A STAR DURING A PHASE TRANSITION. Seidov, Z. F. (Astrophysical Observatory, Shemakha, USSR). Astrophysics (Engl. Transl.), 3: 90-5(Summer 1967).

Translated from Astrofizika, 3: 189-201(1967).

The equilibrium of a star whose matter is undergoing a phase transition is considered, and the behavior of the stellar parameters near the transition point is investigated. It is shown that dM/dR is everywhere continuous. A derivation is given of the critical density ratio at phase transition, which leads to loss of stability immediately after the appearance of the new phase. Polytropic stars undergoing a phase transition and having $\bar{n} = 0$ and $\bar{n} = 1$ are considered in detail, and analytical expressions are obtained for the star parameters as a function of the central equilibrium. (auth)

**30222** STABILITY OF COLLISIONLESS GRAVITATING SYSTEMS. Milder, D. Michael (Harvard Coll. Observatory, Cambridge, Mass.). Bull. Astron., 3: 299-304(1968).

On the basis of studies of Antonov and Lynden–Bell the collective stability of certain collisionless gravitating systems can be determined. Antonov's necessary and sufficient stability criterion and Lynden–Bell's less-delicate but more tractable sufficient stability criterion are both derived from the time-dependent Vlasov equation linearized about equilibrium phase density solutions of the type $f(\vec{r},\vec{v}) = F(J)$, J being the particle

energy in fixed or rotating coordinates. A surprising feature of Lynden–Bell's criterion is that it is formulated solely in terms of a "hydrostatic" quantity related to the spatial density $p(\vec{r})$, and is valid without formal modification for compressible fluid systems. A complementary treatment of collective stability based on a variational principle is presented here. The variational principle resembles the "energy principle" mentioned in Lynden–Bell's study and yields the same sufficient criterion for stability. At the same time, there emerges from the variational treatment an extended analogy with gravitating fluid systems, in which the stability criterion is revealed as the counterpart of the classical condition for secular stability. (BBB)

**30223** NUMERICAL EXPERIMENTS ON ONE-DIMENSIONAL STELLAR MODELS. Feix, Marc R. (Univ., Nancy, France); Hohl, Frank. Bull. Astron., 3: 389-98(1968). (In French).

Different computer models of the one-dimensional (plane sheets) stellar problem are reviewed. The scaling problem is discussed, i.e., the influence of the number of particles treated (much smaller of course than in any real situation) and the relation between one-dimensional and real (3-dimensional) models. Results obtained for two problems are presented: (1) the fast relaxation of a nonstationary state which according to Lynden–Bell, should relax to a kind of Fermi–Dirac distribution, and (2) the slow relaxation to the thermal equilibrium. Exact detailed calculations of trajectories are performed for a small number of stars ($N \simeq 20$). The microscopic fluctuations are studied and are shown to exhibit a strong oscillatory character. (BBB)

**30224** ORIGIN OF THE ELEMENTS. Clayton, Donald D. (Rice Univ., Houston, Tex.). Phys. Today, 22: No. 5, 28-36 (May 1969).

Observations of stellar spectra, combined with laboratory data on nuclear reactions, are used in attempting to explain the origin of the elements. Topics reviewed in some detail include elements in the Sun, meteorites, elements in the stars, big-bang Universe, the helium mystery, carbon/nitrogen cycle, solar neutrinos, abundance of oxygen-16, carbon burning, silicon burning, and elements heavier than iron. (W.D.M.)

**30225** A COVARIANT TREATMENT OF RELATIVISTIC PLASMA OSCILLATIONS IN THE PRESENCE OF AN EXTERNAL MAGNETIC FIELD. Tam, Kwok-kee; O'Hanlon, John (Univ. of British Columbia, Vancouver). Can. J. Phys., 47: 1057-60 (May 15, 1969).

A covariant theory of plasma oscillations for a many-component plasma in the presence of an external magnetic field is formulated. (auth) (Canada)

**30226** RUNAWAY CENTERS. Lynden-Bell, D. (Royal Greenwich Observatory, Eng.). Bull. Astron., 3: 305-7(1968).

Antonov's result concerning the locally maximal entropy state for a gas of point gravitating particles is explained. Antonov showed that there is no locally maximal entropy state for a gas of point gravitating particles confined by a spherical box if the radius of the box is greater than $0.335\ GM^2/(-E)$. Here G is the constant of gravitation, M the total mass, and E the total energy (assumed negative). Why this happens is explained. In the gaseous case, assuming that the gas has little thermal conductivity, the outer parts of the gas mainly held in by the box will expand but the inner parts mainly held in by the gravity of the system will expand less. As a result of adiabatic cooling, the outer parts will end up somewhat colder than the less-expanded interior. Now as the thermal conductivity acts, heat will flow down the temperature gradient from the interior which will contract and get hotter like a star. The outer parts will receive the heat and get hotter also. The inside, which had the greater temperature to start with, is getting hotter by using heat while the outside is getting hotter by gaining it. If the heat capacity of the outside is small, then it will get hotter faster than the inside and will therefore catch up in temperature. Equilibrium is thus reached. However, if the isothermal sphere is too well developed, then the outside will have a large heat capacity so a given heat gain will cause it to increase its temperature less than the temperature increase of the inside consequent on its loss of the heat. Then a thermal runaway occurs, the temperature difference increasing without limit as heat is transferred. There is nothing to stop it in a stellar system until stars collide. Evolution along the thermal runaway will lead to very concentrated centers in stellar systems and possibly to the formation of galactic nuclei. (BBB)

**30227** THE INTRINSIC POLARIZATION OF MIRA VARIABLES. Harrington, J. P. (Univ. of Maryland, College Park). Astrophys. Lett., 3: 165-8(May 1969).

It is shown that light emerging from the atmospheres of Mira variables may exhibit a degree of polarization much higher than the classical value for a pure scattering atmosphere. It is suggested that temperature variations over the stellar surface could lead to a large observable polarization. (auth)

**30228** PRESENCE OF Fe IV IN SPECTRUM OF MHα 328116. Bloch, M. (Observatoire de Lyon); Swings, J. P. Astrophys. Lett., 3: 141-3(May 1969). (In French).

The possible presence in the spectrum of V 1016 Cyg of three lines of Fe IV (4152.0, 4206.5, and 6996.6 Å) is discussed. (tr-auth)

**30229** SPECULATIONS ON THE LIGHT ELEMENT ABUNDANCES IN STARS. Epherre, M. (Institut de Physique Nucleaire, Orsay, France); Reeves, H. Astrophys. Lett., 3: 145-7(May 1969).

The abundances of light elements in stars are discussed in terms of recent results concerning the abundances and cross sections. (auth)

**30230** A SPECTROSCOPIC FLARE OF WOLF 359. Greenstein, J. L.; Arp, H. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. Lett., 3: 149-52(May 1969).

A spectrum of a flare on Wolf 359, dM8e, was obtained with the 200-inch Palomar telescope. Hydrogen and helium emission lines are enhanced, broadened, and violet-shifted. The chromosphere is normally like that of the Sun, and the flare phenomenon similar in absolute energy scale. The flare did not veil the absorption-line spectrum. Chromospheric and flaring activity would suggest that the star is relatively young, but the space motion of 57 km/sec places it in the old disk population. Infrared observations kindly supplied by Neugebauer and Becklin show that this dM8e star fits a black body with a very low temperature, near 2500°K. (auth)

**30231** WATER-BAG MODEL IN SPHERICAL SYMMETRY. Doremus, J. P.; Feix, M. R.; Baumann, G. (Laboratoire de Physique Theorique Nucleaire et d'Astrophysique, Nancy). Astrophys. Lett., 3: 137-8(May 1969). (In French).

In a spherically symmetrical system, the water-bag model is equivalent to a polytrope of index $n = 3/2$. It is shown that the equilibrium corresponds to a minimum of the total energy which implies the stability of such a system, generalizing results obtained in one-dimensional systems. (auth)

**30232** INTERSTELLAR BAND ABSORPTION IN A SUPERNOVA. Seddon, H. (Royal Observatory, Edinburgh). Nature (London), 222: 757(May 24, 1969).

It is considered that interstellar dust consists basically of graphite, with or without various coatings on the grains, and it has been suggested that the grains could be formed in the explosion of supernovae. It has also been suggested that because there is a strong correlation between reddening and the strength of diffuse interstellar bands, the latter may be attributable to electronic transitions in impurities in the grains, coupled to lattice vibrations. Some observational evidence for this has been obtained. The impurities may be introduced into the grains by high-energy-particle bombardment. The bands are difficult to study in detail because of their weakness and width, and spectra of supernovae are difficult to obtain. Spectra of a supernova in NGC 2713 in March 1968 were, however, obtained and are reproduced and discussed. (UK)

**30233** PHYSICAL EXPLANATION OF DIFFICULTIES APPEARING IN THE THEORY OF TOROIDAL MAGNETOHYDRODYNAMIC OSCILLATIONS. Burghes, D. N. (Univ. of Sheffield, Eng.); Kendall, P. C.; Sweet, P. A. Mon. Notic. Roy. Astron. Soc., 143: 9-16(1969).

Toroidal magnetohydrodynamic oscillations frequently give rise to terms of the form t cos (kt), t sin (kt) (secular terms) in the component of the perturbed electric current parallel to the permanent magnetic field. A physical explanation of the existence of such secular terms is given and it is shown that in practical applications the parallel component of electric current does not in fact grow indefinitely with time. Estimates of the time of decay of toroidal oscillations are found; it is shown, both in general, and by reference to the Plumpton–Ferraro oscillating shell problem, that for nonaxial and nonequatorial shells the ratio of the time of decay of currents to the time of decay in a rigid conductor of the same size and conductivity is given by $(\eta/aV_A)^{\frac{1}{2}}:1$. Here a is a typical length, $V_A$ the Alfvén velocity and $\eta$ the magnetic viscosity. The quantity $(\eta/aV_A)^{\frac{1}{2}}$ is usually small and the decay of electric currents of toroidal oscillations is therefore much faster than the decay of currents in a rigid conductor of the same size and conductivity. This comment applies to many general systems in which waves propagate along field lines and are reflected many times from fixed boundaries, and must be borne in mind when considering the toroidal magnetohydrodynamic oscillation of stars. (auth)(UK)

**30234** GRAVITATIONAL COLLAPSE OF A SLOWLY ROTATING RELATIVISTIC STAR. Silk, Joseph; Wright, James P. (Harvard Coll. Observatory, Cambridge, Mass.). Mon. Notic. Roy. Astron. Soc., 143: 55-71(1969).

The coupling between the angular momentum of a collapsing star and the gravitational field is discussed. A rotational perturbation is applied to a spherically symmetric, time-dependent interior solution of the Einstein field equations. Equations are derived for the perturbed metric component $h_{03}$, which demonstrate the effects of the collapse, and solutions are given to order $c^{-5}$. An application of these results to the general relativistic law of conservation of total angular momentum indicates that appreciable Newtonian angular momentum may be dissipated during the final stages of gravitational collapse. Post-Newtonian terms in the angular momentum, together with estimates of the time scale for this effect, are given for a sequence of polytropic stellar models. It is also found that the effect of general relativity is to increase the angular momentum above its Newtonian value for a uniformly rotating star of low eccentricity and of given equatorial radius, this effect increasing with central condensation of the star. (auth) (UK)

**30235** EARLY EVOLUTION OF THE NUCLEI OF PLANETARY NEBULAE. Webster, B. Louise (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc., 143: 113-27 (1969).

The magnitudes of the nuclei of planetary nebulae in the Magellanic Clouds and the Galaxy were measured photoelectrically at three wavelengths. These observations were combined with previous measurements of the hydrogen and helium line strengths to derive the luminosities and temperatures of the nuclei. The Hertzsprung–Russell diagram obtained confirms that the luminosity of a central star increases with temperature in its initial stages. A displacement of the track of the Small Magellanic Cloud nuclei from that of the Large Cloud may be caused by a difference in mass. (auth)(UK)

**30236** MASSES AND GALACTIC DISTRIBUTION OF SOUTHERN PLANETARY NEBULAE. Webster, B. Louise (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc., 143: 79-95(1969).

Photoelectric measurements of absolute emission-line fluxes of far-southern planetary nebulae were made. Thirty objects in the Magellanic Clouds and 88 objects in the Galaxy were included. Faint unresolved (planetary) nebulae in the Clouds are excited by stars below the main sequence, whereas the stars in the more luminous, resolved (diffuse) nebulae lie on, or near, the main sequence. The upper limit to the total Hβ emission of any Magellanic Cloud planetary is $2.5 \times 10^{35}$ erg $s^{-1}$. A discussion of present and previous mass determinations leads to a best estimate for the total mass of a planetary shell of between one tenth and one quarter of a solar mass. Approximate distances to the galactic planetaries were calculated. The peak in the number of planetaries toward galactic longitude $l^{II} = 330°$ is caused to some extent by the large number of typical planetaries there, but the main factor is low interstellar absorption in this direction. (auth)(UK)

**30237** INFRARED COLOURS OF G, K, AND M STARS. Bahng, J. (Northwestern Univ., Evanston, Ill.). Mon. Notic. Roy. Astron. Soc., 143: 73-7(1969).

The results of intermediate band photometry of late-type stars in the infrared indicate that the continuous radiation of these stars deviates noticeably from that of black bodies. An emission peak near 1.6 μ was observed in agreement with other observations. It is suggested that the prominence of the 1.6 μ peak is a result of a combination of $H^-$ and $H_2^-$ on the one hand and $H_2O$ on the other as sources of continuous opacities. In G and K stars, this feature is primarily caused by $H^-$ and $H_2^-$. In the M stars it is predominantly caused by $H_2O$, but the contribution of $H^-$ and $H_2^-$ tends to enhance this feature over other peaks that are also caused by $H_2O$. (auth)(UK)

**30238** SEARCH FOR NANOSECOND OPTICAL PULSES FROM CRAB PULSAR NP 0532. Anderson, J. A.; Crawford, F. S.; Cudaback, D. D. (Univ. of California, Berkeley). Nature (London), 222: 861-2(May 31, 1969).

A search is described which was made on March 13 and 22, 1969, for short optical pulses coming directly from the south preceding star of the Crab central double, using the 120 inch Lick Observatory telescope. This star had previously been stated to be an optical pulsar with the 33-ms period of NP 0532. No such pulses were found in several 5-min observations, each corresponding to some 9,000 pulsar pulses. It was concluded that the amount of optical radiation bunched into time intervals of $10^{-18}$ sec was less than 10%, and that the same appeared to apply for time intervals up to $10^{-4}$ sec. (UK)

## *Quasi-Stellar, Radio, and X-Ray Sources*

**30239** (N-69-19783) POSSIBLE APPLICATIONS OF THE CONTINUITY-EQUATION PLASMA OSCILLATION TO PULSARS AND OTHER PERIODIC ASTROPHYSICAL PHENOMENA. Roth, J. Reece (National Aeronautics and Space Administration, Cleveland, Ohio, Lewis Research Center). Mar. 1969. 60p. (NASA-TN-D-5078). CFSTI.

The continuity equations for neutral and charged particles in a partly ionized gas may possess periodic solutions. These oscillations are suggested as a possible clock mechanism for periodic astrophysical phenomena such as geomagnetic micropulsations, pulsars, and of long-period fluctuations in the charged-particle density of the interstellar medium. A mathematical model of these oscillations is derived and applied to two cases of astrophysical interest: an isolated, virtually uniform region of partially ionized gas; and a slightly ionized stellar or planetary atmosphere, the characteristics of which vary with position. The theoretical analysis is supplemented by an experimental investigation of the pulsed production and loss of electrons from a magnetically confined laboratory plasma which was subject to the continuity-equation oscillation. Some pulsar like characteristics were observed and measured in this plasma. (auth) (STAR)

**30240** (N-69-19890) IRON LINE EMISSION FROM X-RAY SOURCES. Holt, S. S.; Boldt, E. A.; Serlemitsos, P. J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Aug. 1968. 10p. (NASA-TM-X-63475; X-611-68-343). CFSTI.

X-ray sources for which thermal models have been proposed should exhibit line structure for energies below 10 keV. The $(1s)^2$ 1/n 1s2p transition in Fe XXV at 6.64 keV is that emission line which is characteristically the most easily observable, and its presence (or absence) in experimentally observed spectra is shown to severely constrain proposed models. (auth) (STAR)

**30241** MEASUREMENTS OF THE FLUX DENSITY AND SPECTRA OF DISCRETE RADIO SOURCES AT CENTIMETER WAVELENGTHS. II. THE OBSERVATIONS AT 5 GHz (6 cm). Pauliny-Toth, I. I. K.; Kellermann, K. I. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. J., 73: 953-69 (Dec. 1968).

The measurements described form part of a program aimed at determining the spectra of extragalactic radio sources at centimeter wavelengths. Flux densities of 480 sources were measured at 5.0 GHz using a 140-ft telescope. These include almost all extragalactic sources in the Revised 3C catalog and some other sources, particularly from the various Parkes catalogs. An accuracy of measurement of better than 0.05 flux unit (1 flux unit = $10^{-26}$ $W/m^2/Hz$) was achieved for most sources. Some interesting optical objects such as Seyfert and compact galaxies and radio-quiet quasistellar galaxies were also observed and radio emission was detected in some of these. The distributions of spectral indices between 6 and 11 cm for radio galaxies, quasistellar sources, and unidentified sources were compared with the corresponding distribution between 21 and 11 cm. Two classes of sources can be distinguished: those with a narrow dispersion of spectral indices about a median value near −0.8 and those with a much larger dispersion of indices about a median value near zero. This separation is more pronounced at centimeter than at longer wavelengths. Radio galaxies, quasistellar sources detected by surveys at meter wavelengths, and unidentified sources fall mainly in the first class; sources in the second class are mainly quasistellar sources detected by surveys at decimeter wavelengths. Unidentified sources tend to have steeper spectra than radio galaxies or quasistellar sources. The spectral index of radio galaxies between 21 and 11 cm is the same as between 11 and 6 cm. (BBB)

**30242** RADIO OBSERVATIONS OF TWO H II REGIONS. Caswell, J. L. (Dominion Radio Astrophysical Observatory, Penticton, B. C.). Astron. J., 73: 949-52(Dec. 1968).

New radio observations at 3200 and 178 MHz were made of the emission nebula NGC 281 and an unnamed nebula near NGC 2264. Using the new data together with previously published work, the spectra and structures of the sources were investigated. NGC 281 is in a region of neutral hydrogen having a density comparable with that in the ionized portion and thus appears to be particularly suitable for comparison with simplified theoretical models. Several models of the dynamical evolution of H II regions assume to render the problem tractable, an initially extensive smooth density distribution. The present observations suggest that the approximation may be reasonable for NGC 281 since the rms density in the nebula is comparable with that of the neutral hydrogen cloud surrounding the nebula. However, more detailed observations are necessary for further comparisons, in particular, higher-resolution observations to investigate further the departures from uniform density. (BBB)

**30243** YEAR OF THE PULSARS. Mitton, S. (Churchill Coll., Cambridge, Eng.). New Sci., 41: 406-8(Feb. 20, 1969).

A review of activity in the field of pulsar studies is presented (to mark the first anniversary of their discovery) under the following headings: CP 1919—the first pulsar; consolidation of studies; distance to CP 0328 measured; discovery of second periodic pulsation; more Molonglo pulsars; change in period detected; and the future. (UK)

**30244** RADIO OBSERVATION OF GALACTIC H II REGIONS AT 4170 MHz. II. Ojima, Takeyuki; Nakajima, Toshio (Radio Research Lab., Tokyo). J. Radio Res. Lab. (Tokyo), 15: 271-8(Nov. 1968).

This is the second report of radio continuum observations of the five galactic H II regions at 4170 MHz successive to the first report in November 1967. The five selected sources of the galactic H II regions are W1, W5, 3C152, W13, and W16. The optical measurement of these sources was made by Ishida, et al. (1968) of the Tokyo Astronomical Observatory. (auth)

**30245** REDSHIFTS OF QUASI-STELLAR OBJECTS AND RELATED EXTRAGALACTIC SYSTEMS. Burbidge, G. R.; Burbidge, E. M. (Univ. of California, San Diego). Nature (London), 222: 735-41(May 24, 1969).

A new expanded list of emission and absorption redshifts of quasi-stellar and related objects has been compiled. The evidence suggests that the absorption lines arise in the QSOs and not in an intervening medium. (auth)(UK)

**30246** RADIO OBSERVATIONS OF PRE-PROTOSTARS. Hughes, V. A. (Queen's Univ., Kingston, Ont.). Nature (London), 222: 733-5(May 24, 1969).

It is suggested that when an interstellar cloud, with associated magnetic field, collapses to form stars, the magnetic energy is dissipated in the acceleration of particles, producing nonthermal radio sources, and that the latter have been observed in the galactic plane. (auth)(UK)

**30247** TRANS-PACIFIC INTERFEROMETER MEASUREMENTS AT 2,300 MHz. Gubbay, J. (Univ. of Adelaide); Legg, A. J.; Robertson, D. S.; Moffet, A. T.; Seidel, B. Nature (London), 222: 730-3(May 24, 1969).

Interferometer observations of ten radio sources are reported, most of them quasars, with a base line between California and Australia. (auth)(UK)

**30248** X-RAY AND OPTICAL OBSERVATIONS OF THE PULSAR NP 0532 IN THE CRAB NEBULA. Bradt, H. (Massachusetts Inst. of Tech., Cambridge); Rappaport, S.; Mayer, W.; Nather, R. E.; Warner, B.; MacFarlane, M.; Kristian, J. Nature (London), 222: 728-30(May 24, 1969).

The existence of a strong pulsed x-ray signal from the pulsar NP 0532 was confirmed. The phases and the shapes of the x-ray and optical pulses are compared. (auth)(UK)

**30249** ANOMALOUS HUBBLE PLOT OF QUASI-STELLAR OBJECTS. Barnothy, J.; Barnothy, M. F. (Univ. of Illinois, Chicago). Nature (London), 222: 759-61(May 24, 1969).

It has been stated that the Hubble plots of redshift versus apparent magnitude of QSOs and N-type radio galaxies appear to define a line having a steeper slope than that required by a redshift–distance relationship for objects of the same luminosity, and it has been shown that the most prominent characteristics of QSOs and of the bright nuclei of N-type radio galaxies are well explained on the assumption that both are images produced by gravitational lenses. When two galaxies are well aligned the foreground galaxy will act as a lens amplifying the brightness of the object behind it. The object of the present communication is to show that if QSOs and the nuclei of N-type radio galaxies are gravitational lens images, then their steeper Hubble plot can be explained. The action of a gravitational lens is described in detail. (UK)

**30250** ROCKET OBSERVATIONS OF VIRGO XR-1. Adams, D. J.; Cooke, B. A.; Evans, K.; Pounds, K. A. (Univ. of Leicester, Eng.). Nature (London), 222: 757-9(May 24, 1969).

Observations are reported from Skylark 723 and 403, the former on June 12 and the latter on July 8, 1968. Count-rate profiles for 20 sky scans from Skylark 723 are shown; peaks were observed in the position of Vir XR-1 consistent with x rays from a single "point" source. In the Skylark 403 observations a systematic increase in count rate was observed in the direction of Vir XR-1. The spectral results of the two sets of observations are summarized graphically. There was overall evidence for a continuously rising spectrum at least to 1.5 keV, and the intensity of the source was estimated as $1.5 \times 10^{-9}$ ergs/cm$^2$/sec in the energy range 1.5 to 5 keV. The observations are compared with those of other studies. The proposed identification of Vir XR-1 with the "radio galaxy" 1787 is discussed, and particularly the possibility that the x radiation arises from synchrotron emission of the relativistic electrons in the optical jet. It is concluded that the 1787 jet is a source of intense optical and radio synchrotron emission, possibly extending to x-ray frequencies. A model is proposed which is analogous to, but on a larger scale than, that proposed by Burbidge and Hoyle for the Crab Nebula supernova remnant. The x-ray emission region may be very localized in each source, and it is an intriguing possibility that differences in measured flux could represent real variability. (UK)

**30251** TIME VARIATION OF THE OPTICAL INTENSITY OF THE SCO X-1 X-RAY SOURCE. Rao, U. R.; Rao, A. S. P.; Jayanthi, U. B. (Physical Research Lab., Ahmedabad, India). Nature (London), 222: 864-5(May 31, 1969).

Previous observations on the optical behavior of this source are briefly reviewed. The present authors subjected all available data to a power spectral analysis, and results of this analysis for optical data on April 18, 1967, are shown graphically. There were no indications of predominant short-term periodicities in the range 2 to 10 min., in agreement with earlier observations, but a long-term periodicity of 3.07 hr was indicated. This is consistent with radio and x-ray observations. (UK)

**30252** RADIO EMISSION OF CYGNUS X-2. Purton, C. R. (York Univ., Toronto). Nature (London), 222: 863-4(May 31, 1969).

It had been suggested that there might be a faint radio source at the position of the x-ray source Cygnus X-2, although it was recognized that the apparent source could be spurious. The present author failed to detect any radio emission in observations at a wavelength of 4.5 cm, using the Algonquin 46 m telescope. (UK)

**30253** SPIN DOWN EFFECTS IN NEUTRON STARS. Greenstein, G. S.; Cameron, A. G. W. (Yeshiva Univ., New York). Nature (London), 222: 862-3(May 31, 1969).

The discovery that pulsar periods are continually increasing is widely accepted as convincing evidence that the pulsar clock mechanism is based on rotation of neutron stars. The present communication discusses, within the framework of this model, the sudden decrease of the period of PSR 0833-45 between Feb. 24 and March 3, 1969. The slowing down of the rotation of a neutron star presumably occurs as a result of torques applied to it through its external magnetic field, and it is pointed out that these torques need not necessarily be applied uniformly to the neutron star as a whole. It is assumed that only the outer layers of the star are subject to braking, with the result that the inner core is rotating more rapidly than the outer layers, and it is well known that differential rotation within a star can be unstable; with the passage of time a braking of the outer layers leads to a gradient of angular momentum per unit mass. It is proposed that the decrease in the period of PSR 0833-45 arose as a result of a sudden onset of such an instability. Sudden mixing of material between inner and outer regions tended to equalize their rotation rates. The instability then ceased and the envelope resumed its deceleration. Equations of state for the neutron star interior are discussed qualitatively. Weak interactions are considered, and it is pointed out that the prominent part played by these interactions in the equation of state assures that fluid instabilities in the interior of a neutron star will lead to intermittent macroscopic mixing rather than to continuous microscopic mixing. (UK)

**30254** PULSAR THEORY OF CHIU, CANUTO, AND FASSIO-CANUTO. Roberts, J. A.; Fahlman, G. G. (Univ. of Toronto). Nature (London), 222: 862(May 31, 1969).

Criticisms are made of the above theory, in which the radio emission from pulsars, which has a brightness temperature exceeding $10^{21}$°K, is considered to be radiation from electrons having kinetic temperatures ~$10^{15}$°K. This suggestion is surprising since it is considered that incoherent processes cannot produce brightness temperatures in excess of the effective temperature of the radiating particles, and the belief that this applies to incoherent synchrotron emission led to the dismissal of that mechanism for pulsar radiation. (UK)

**30255** STUDY OF THE 21-cm LINE IN THE SOLAR NEIGHBOURHOOD. Venugopal, V. R.; Shuter, W. L. H. (Univ. of British Columbia, Vancouver). Mon. Notic. Roy. Astron. Soc., 143: 27-35(1969).

A survey of 1200 profiles of 21-cm line emission at points equally spaced over the entire sky visible from Penticton, British Columbia, was made. A selection of the line profiles at intermediate galactic latitudes was used to determine several of the properties of the distribution of the nearby gas, and to derive the velocity ellipsoid describing the random gas motions. The vertex direction of the velocity ellipsoid was found to be closely aligned with the local magnetic field, supporting the view that the random motion is influenced by the field. (auth)(UK)

## Solar Phenomena

*Refer also to abstracts 30368 and 30591.*

**30256** RADIATION EFFECTS ON EARTH SATELLITES AND SOLAR PROBES DURING SOLAR FLARES. Wohlleben, K. Siemens AG, Erlangen, Ger.). Raumfahrtforschung, 13: 54-61(Mar.-Apr. 1969). (In German).

The radiation effects caused by solar flare protons is examined for earth satellites and solar probes. The calculations are based on the annual flux of solar protons near to the Earth's orbit estimated from empirical relationships with the sunspot number for sunspot cycle 20 (1965–1975), account being taken of the propagation of solar protons in interplanetary space and the shielding effect of the Earth's magnetic field. For the planned solar probe (perihelion 0.3 AU aphelion 1.0 AU) a cumulative radiation effect 2.8 times greater than in 1 AU is anticipated. With an equatorial synchron satellite and a shielding thickness < 0.5 g/cm$^2$—as well as with the AZUR satellite—the cumulative radiation effects (defects/cm$^3$a, Rad/a, solar cell damage/a) are always smaller than the effects produced by Van Allen radiations. On the other hand, the maximum dose rate (Rad/s) by solar protons is comparable with that of the Van Allen radiations (AZUR) or greater than the latter (synchron satellite with shielding >0.5 g/cm$^2$). (auth)

**30257** MAGNETIC FIELDS, GREEN CORONA, AND FILAMENTS IN HIGH SOLAR LATITUDES. Bumba, V.; Ruzickova-Topolova, B. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 20: 63-7(1969).

From the study of synoptic charts representing the distribution of photospheric magnetic fields, green coronal emission, and filaments during the declining part of the recent cycle of solar activity, especially in higher heliographic latitudes, some new data about the relations of all these phenomena were obtained: (1) In the activity zone the field configurations strongly influences the position and intensity of green corona emission. (2) In higher latitudes the maxima of the green corona seem to be bound to the tails of the following polarity, pushed out from the body of the BMF. (3) The large quiescent filaments lay in the valleys of intensity minima of the green corona along the boundaries of magnetic field polarities. (4) The development of polar magnetic fields and related green corona emission are closely related to the complex situation connected with "active longitudes." (5) During the studied time-interval the magnetic field and corona emission do not shift into regions with heliographic latitude greater than 65°. (auth)

**30258** RELATION OF 1420-MHz RADIO EMISSION TO THE DISTRIBUTION OF PHOTOSPHERIC MAGNETIC FIELDS, CORONAL EMISSION, AND FILAMENTS. Bumba, V.; Kleczek, J.; Olmr, J.; Ruzickova-Topolova, B. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 20: 67-9(1969).

The 1420 MHz brightness, the 5303 Å brightness, and filament location are determined by the large-scale pattern of photospheric magnetic fields. The increase of the brightness is explained by the increase in density of the coronal plasma over a large-scale magnetic field. Such a density increase, in its turn, seems to play an important role in the replenishment of coronal material. (auth)

**30259** THE PHOTOSPHERIC MAGNETIC FIELD STRUCTURE AND CORONA IN A SMALL COMPLEX OF ACTIVITY. Sykora, J. (Astronomical Inst., Skalnate Pleso, Czech.). Bull. Astron. Inst. Czech., 20: 70-3(1969).

Magnetic, photospheric, chromospheric, and coronal observations were used for a morphological study of the development of the separate complex of activity. Predominantly the following polarity of the photospheric magnetic field shows structural changes in the course of the development of the complex. An approximately 54-day period of appearance of the sunspot groups in the complex of activity is apparent. A positive dependence between the green corona intensity and the complexity of the magnetic situation is very distinct. Owing to this marked dependence the course of the corona intensity seems to be in disagreement with the development of some other features of solar activity. The positions of corona intensity maxima (coronal peak-ranges) with regard to the centers of gravity of the magnetic field are irregular, and mutual departures reach as many as seven degrees in heliographic latitude. It seems to be true that there exist essential changes in the position of corona peak-ranges during a few hours. (auth)

**30260** DYNAMIC SPECTRUM OF SOLAR X-RAY BURSTS. Pinter, S. (Geophysical Inst., Hurbanovo, Czech.). Bull. Astron. Inst. Czech., 20: 73-5(1969).

A new method is proposed for the study of solar x-ray bursts by means of dynamic spectrum. Dynamic spectra of solar x-ray bursts were received on a basis of the time history of intensity of x-ray bursts which have been observed within many isolated ranges of the spectrum by OSO-III. An event observed on March 22, 1967 is analyzed. (auth)

**30261** A STATISTICAL RAY ANALYSIS OF THE SCATTERING OF RADIO WAVES BY THE SOLAR CORONA. Hollweg, Joseph V. (Max Planck Institut fuer Extraterrestrische Physik, Garching, Ger.). Astron. J., 73: 972-82(Dec. 1968).

Multiple scattering of radio waves from coronal irregularities may provide a method of investigating turbulence in the solar corona and solar wind in regions currently inaccessible to solar probes. Scattering of radio waves by an anisotropically turbulent solar corona exhibiting large-scale refraction (due to a radial gradient in average electron density) is discussed in terms of a statistical ray analysis similar to that of Chandrasekhar. The corona is assumed to be spherically symmetric throughout. The ray equations of geometrical optics are written in terms of the spherical coordinate system natural to the solar corona, and discussed for the case of an anisotropically turbulent corona for which the electron density may be known in only a statistical sense. A linear perturbation analysis is employed to obtain explicit solutions for the statistical fluctuations in the ray position, signal phase, and pulse propagation times. The general expressions thus obtained are discussed in particular for the special case of nearly linear rays. It is shown that at appropriate frequencies even very slight ray bending can have a significant effect on the fluctuations in the times of propagation of pulse signals across the corona. The scattering data available at present are consistent, beyond some 10 solar radii, with a coronal density behaving as $r^{-2}$, a degree of anisotropy nearly constant with distance from the sun, and a statistical correlation length which during solar minimum does not vary with (r), but which tends to increase linearly with (r) near solar maximum indicating that the interplanetary plasma develops a radial filamentary structure as solar maximum is approached. In the region 3 to 6 solar radii, $a^2/b \simeq r^3$, where a is the correlation length in the radial direction and b the correlation length in the transverse direction. This behavior can result if both the anisotropy ratio a/b and the transverse correlation length vary linearly with r in that region. (BBB)

**30262** SOLAR SOURCES OF RECURRENT GEOPHYSICAL EFFECTS. Bumba, V.; Howard, R. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 20: 61-2(1969).

A comparison of recurrent geophysical disturbances with solar active regions and with the persistent low-latitude background field pattern in the magnetic fields on the solar surface leads one to conclude that the geophysical effects result from a certain strength of this background field pattern. This critical level of strength comes about in some longitude zones on the Sun from a decrease in the number of active regions during times of high activity or during the minimum from a continuous moderate "stream" of activity. (auth)

**30263** CORONAL STRUCTURE AT THE SOLAR ECLIPSE OF SEPT. 22, 1968. Schatten, K. H. (Univ. of California, Berkeley). Nature (London), 222: 652-3(May 17, 1969).

Reference is made to the author's prediction of the coronal structure to be expected during the above eclipse (Nature 220: 1211(1968)), and comparison is made with some photographs obtained during this eclipse. The predictions and the observations appear to have several features in common, particularly with reference to streamers, open-rayed configuration, and condensations. (UK)

**30264** NUMERICAL SIMULATION OF FLARE-GENERATED DISTURBANCES IN THE SOLAR WIND. Hundhausen, A. J.; Gentry, R. A. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res., 74: 2908-18(June 1, 1969).

The propagation of flare-generated shock waves through the solar wind is examined using numerical solutions of the time-dependent hydrodynamic equations. These solutions are valid for all shock strengths, including the intermediate values that have been observed in the solar wind, and take into account the variation of the properties of the ambient solar wind. The entire range of time scales for energy deposition in the disturbance, from impulsive (producing "blast waves") to continuous deposition, is considered. For the former class of disturbances the solutions approach a limiting form dependent only on the total energy in the wave. Relationships among the energy, shock strength at 1 AU, and transit time at 1 AU are found in the blast wave limit. For disturbances with energies near $10^{31}$ ergs, the wave propagates from the Sun to 1 AU in ~60 hours, and is preceded by an intermediate strength shock at the latter distance. Both the transit time and shock strength are in good agreement with directly observed values. (auth)

**30265** ELECTROSTATIC HEATING OF SOLAR WIND IONS BEYOND 0.1 AU. Fredricks, R. W. (Space Sciences Lab., Redondo Beach, Calif.). Contract NASW-1598. J. Geophys. Res., 74: 2919-22 (June 1, 1969).

It is argued that the large electron–proton temperature ratio predicted by the Hartle–Sturrock two-fluid solar wind model may be unstable to generation of ion–acoustic waves beyond 0.1 AU, and that this instability is capable of providing a turbulent mechanism for the preferential heating of protons to produce ratios $T_e/T_p \lesssim 5$ to 10 near 1 AU in accord with experimental observations. (auth)

**30266** THE RADIAL DEPENDENCE OF THE INTERPLANETARY MAGNETIC FIELD: 1.0 TO 1.5 AU. Coleman, Paul J. Jr. (Univ. of California, Los Angeles); Smith, Edward J.; Davis, Leverett Jr.; Jones, Douglas E. J. Geophys. Res., 74: 2826-50 (June 1, 1969).

Measurements of the interplanetary magnetic field between the orbits of the Earth and Mars were used to study the radial dependence of the field. The measurements were obtained with Mariner 4 over the period from November 28, 1964, to July 14, 1965. For the strength of the quiet-day field the best-fit power-law function of heliocentric range r was $B = 4.13\ (r/r_\oplus)^{-1.25}$, where 1.0 AU < r < 1.5 AU, $r_\oplus = 1.5$ AU, and the units are $10^{-5}$ gauss = 1 $\gamma$. Over this range of r the power-law approximation for the strength of an ideal spiral field in a solar wind of 350-km/sec velocity is proportional to $(r_\oplus/r)^{-1.29}$. Thus, the measured radial dependence of B was nearly that predicted for a spiral field. The measured field strength includes a contribution from the mean vector field $B_M$, which lay in the spiral-field plane (roughly parallel to the solar equatorial plane) and a contribution from a transverse perturbation field. The radial dependence of the strength of the mean vector field was $B_M = 3.25\ (r_\oplus/r)^{-1.23}$, again in approximate agreement with the spiral-field model. The mean absolute values of the separate vector components did not exhibit the spiral-field behavior, nor did the spiral angle. This angle changed very little with r. The fluctuations transverse to $B_M$ were divided into two components, one in the spiral-field plane and the other normal to this plane. For the rms amplitudes of these two components the best-fit power-law functions were $1.46\ (r/r_\oplus)^{-1.22}$ and $2.11\ (r/r_\oplus)^{-1.44}$, respectively. For the rms amplitude of the fluctuations parallel to $B_M$ the function was $1.35\ (r/r_\oplus)^{-0.54}$. The amplitude of the transverse fluctuations in the spiral-field plane, measured relative to the magnitude of $B_M$, was roughly independent of r while the amplitude of the transverse fluctuations normal to this plane decreased as r increased. The relative amplitude of the parallel or compressional fluctuations grew as $r^{0.49}$. Extrapolation of this function yields $\Delta B/B \simeq 1$ at 4.3 AU. These results apply to fluctuations in the frequency range from $10^{-5}$ to $10^{-2}$ Hz. The estimated radial dependences indicate that an appreciable part of the observed fluctuations was produced by dynamical processes in the solar-wind plasma. In other words, this part of the fluctuations could not have been produced by quasi-static irregularities frozen into the solar wind. The amplitude of the fluctuations, which was 0.4 to 0.7 B at 1.0 AU, suggests that nonlinear processes are important in their production. During the flight the strength and variability of the field exhibited a strong positive correlation with geomagnetic activity as measured by Kp. (auth)

**30267** LOW-ENERGY SOLAR PROTONS AND ALPHAS AS PROBES OF THE INTERPLANETARY MEDIUM: THE MAY 28, 1967, SOLAR EVENT. Lanzerotti, L. J. (Bell Telephone Labs., Murray Hill, N. J.). J. Geophys. Res., 74: 2851-68 (June 1, 1969).

The low-energy solar protons and alpha particles detected during the May 28 (day 148), 1967, solar flare are used as "probes" to investigate the properties of the interplanetary medium during the course of the event. The lower energy fluxes exhibit characteristics of particle storage either at the Sun or in interplanetary space. The higher-energy particle fluxes exhibit "classical" west limb flare profiles and are fit both to a simple isotropic diffusion-with-boundary model and to a radial dependent scattering center model. The diffusion coefficient model of Jokipii is used with the results of a fit to the exponential decay of the event to predict an $f^{-3}$ dependence of the power spectral density of the interplanetary magnetic field fluctuations (assuming a boundary location independent of rigidity). The ratio of particle fluxes before and after a sudden, discontinuous flux decrease (attributed to a sector boundary) is found to be $\sim R^3$ for protons and $\sim R^4$ for alphas for particles with rigidities $\lesssim 200$ MV. Significant velocity dispersions are discovered in three of the flux modulations during the onset stage of the event. The velocity dispersions in one of these modulations could be interpreted as due to a modulating region located ~0.03 AU from the Earth. It is speculated that this region was responsible for an sc at the Earth some two hours later. (auth)

**30268** MEASUREMENT OF THE SOLAR WIND DIRECTION WITH THE IMP 1 SATELLITE. Egidi, A.; Pizzella, G.; Signorini, C. (Univ., Rome). J. Geophys. Res., 74: 2807-14 (June 1, 1969).

The direction of the solar wind has been measured by analyzing the data obtained with the MIT Faraday cup on the IMP 1 satellite. During the period November 27, 1963, to February 24, 1964, the solar wind was, on the average, in the ecliptic plane (50% of cases between −2° and +2°) and came from west of the Sun on 72% of the cases; the average value of the ecliptic longitude was −1.5°. If a systematic error of 1° is allowed, the above figures become 56% and 86% in the two extreme cases. This result indicates that, in the above period of time, the solar wind has tendency to anticorotate with the Sun. (auth)

**30269** SEARCH FOR A LUNAR WAKE AT LARGE DISTANCES FROM THE MOON: MARINER 4. Jones, D. E. (Brigham Young Univ., Provo, Utah); Smith, E. J.; Davis, L. Jr.; Coleman, P. J. Contract NASW-7 (EJS). J. Geophys. Res., 74: 3037-41 (June 1, 1969).

Measurements of the magnetic field with Mariner 4 as it passed near an extension of the Sun–Moon line (23 $R_m$ below and 197 $R_m$ behind the Moon) on November 29, 1964, are reported, and are compared with the results obtained by Ness. (W.D.M.)

**30270** THE SOLAR FLARE OF JULY 8, 1968. Van Allen, J. A.; Wende, C. D. (Univ. of Iowa, Iowa City). Contract Nonr-1509(06). J. Geophys. Res., 74: 3046-8 (June 1, 1969).

In view of the very considerable interest in the July 8, 1968, event, soft x-ray data observations with Explorer 33 and Explorer 35 reduced to absolute flux F (2 to 12 A) are reported. A composite curve of absolute solar x-ray flux is given. Comparative time dependences of absolute x-ray flux and 15,375-mHz radio power spectral flux density are shown. (W.D.M.)

**30271** TURBULENT TRANSPORT, SOLAR LITHIUM, AND SOLAR NEUTRINOS. Schatzman, E. (Institut d'Astrophysique, Paris). Astrophys. Lett., 3: 139-40 (May 1969).

The assumption of a slow turbulence, producing a turbulent diffusion inside the Sun, can explain the solar spin-down, the depletion of lithium at the surface of the Sun, and the neutrino discrepancy. The diffusion coefficient has the same order of magnitude for the three different processes. Conclusions are drawn concerning stellar evolution. (auth)

**30272** UNUSUAL 1- TO 5-GHz SOLAR RADIO EMISSION OF OCTOBER 29, 1968. Mennella, R. A.; Reid, J. H. (Manned Spacecraft Center, Houston, Tex.). Astrophys. Lett., 3: 129-32 (May 1969).

On October 29, 1968, solar activity produced one of the largest, if not the largest, burst of solar microwave radiation ever measured of 1.420 GHz. The activity occurred between 15:15 to 16:52 UT and provided peaks of $379{,}000 \times 10^{-22}$ W m$^{-2}$ Hz$^{-1}$, $5370 \times 10^{-22}$ W m$^{-2}$ Hz$^{-1}$, and 570 W m$^{-2}$ Hz$^{-1}$ at 1.420 GHz, 2.695 GHz, and 4.995 GHz, respectively. The solar radio emission appears to have originated from an active region which was just behind the west limb. (auth)

## Galaxies

**30273** FREQUENCY OF SUPERNOVAE IN CLUSTERS OF GALAXIES. Barbon, Roberto (California Inst. of Tech., Pasadena). Astron. J., 73: 1016-20 (Dec, 1968).

A calculation of the frequency of supernova explosions is given which is based on the results of the search carried out with the 48-in. Schmidt telescope in the period from September 17, 1957 to June 30, 1967. In this period, 45 supernovae appeared in 2144 galaxies, mostly cluster members, listed in Zwicky's Catalogue of Galaxies and Clusters of Galaxies. An average frequency of one supernova per galaxy per 316 yr was found, in satisfactory agreement with the frequency derived in previous computations. The possibility that the frequency of occurrence of supernovae in field galaxies differs slightly from the one found for clusters was investigated. The distribution of the supernovae according to the morphological type of their parent galaxies was also studied. (auth)

**30274** GRAVITATIONAL EXPERIMENTS WITH A CYLINDRICAL GALAXY. Hockney, R. W. (Langley Research Center, Hampton, Va.). Bull. Astron., 3: 199-206 (1968).

A collisionless computer model was used to perform gravitational experiments with a 2-dimensional galaxy. The motion of 2000 rods of mass was computed step-wise in time as they moved according to Newton's laws of motion in their mutual gravitational field. The results are displayed as a movie and show the types of galactic structure that can arise from purely gravitational effects. A galaxy with insufficient rotation to balance gravitational attraction is seen to collapse and form filamentary condensations, then to change through structures similar to the spirals and barred

spirals, and finally to settle down to a cylindrical form reminiscent of an elliptical galaxy. (auth)

**30275** ABSOLUTE MAGNITUDES OF SUPERNOVAE. Kowal, Charles T. (Mt. Wilson and Palomar Observatories, Calif.). Astron. J., 73: 1021-4(Dec. 1968).

Previous attempts to obtain the average absolute magnitudes of supernovae have been hampered by the scarcity of complete light curves, so that the results depended heavily on extrapolated magnitudes. Now, however, almost 40 light curves are available which provide reasonably reliable magnitudes for the supernova maxima. By using luminosity classifications of galaxies, or by other techniques, it is possible to estimate the distances, and therefore the absolute magnitudes of the supernovae, in terms of an assumed Hubble constant. A table lists the data for all supernovae that have well-determined maxima. The maxima were seldom extrapolated by more than 0.25m; exceptions are listed. Absolute magnitudes of 33 supernovae are given. For supernovae of type I, the average absolute magnitude is $M_{pg} = -18.6 + 5 \log (H/100)$. For type II, the average is $M_{pg} = -16.5 + 5 \log (H/100)$. These values are lower limits, which neglect the effects of absorption within the parent galaxies. The redshift–magnitude relation for type I supernovae is shown, and the usefulness of these supernovae as distance indicators is discussed. (BBB)

**30276** THREE-COLOR PHOTOMETRY OF STEPHAN'S QUINTET. Kalloglyan, A. T.; Kalloglyan, N. L. (Astrophysical Observatory, Byurakan, USSR). Astrophysics (Engl. Transl.), 3: 99-106(Summer 1967).

Translated from Astrofizika, 3: 209-21(1967).

The results of detailed three-color photometry of all the galaxies in Stephan's quintet are reported. Integral stellar magnitudes and U – B and B – V color indices were determined. Brightness and color distributions along the principal axes of the galaxies are given, and U – B and B – V diagrams are constructed for each galaxy. Some observational evidence suggesting that NGC 7320 is a member of the system is put forward. (auth)

**30277** MASS DISTRIBUTION IN GALAXIES DEDUCED FROM RADIAL-VELOCITY AND PHOTOMETRY DATA. Sizikov, V. S. (Leningrad State Univ.). Astrophysics (Engl. Transl.), 3: 124-8(Summer 1967).

Translated from Astrofizika, 3: 267-77(1967).

A model of a galaxy in the form of an inhomogeneous spheroid with variable sphericity is proposed. Integral equations connecting the density, sphericity, and the mass–luminosity ratio with the law of circular rotation in the plane of symmetry and with photometric results are derived and solved. A method is given for finding circular velocities in the plane of symmetry. (auth)

**30278** GALAXIES WITH AN ULTRAVIOLET CONTINUUM. Markanyan, B. E. (Astrophysical Observatory, Byurakan, USSR). Astrophysics (Engl. Transl.), 3: 24-38(Spring 1967).

Translated from Astrofizika, 3: 55-68(1967).

A list of 70 faint mainly spheroidal galaxies with early-type spectra has been compiled; these galaxies are similar to the bright galaxies previously studied with abnormal spectra and abnormal colors in the central regions. These galaxies were found during observations with a 1.5° objective prism mounted on a 40″ Schmidt telescope. The principal feature, which distinguishes these objects from the majority of other galaxies is a strong ultraviolet continuum and, occasionally, also emission lines in their spectra. The spectra of galaxies with an ultraviolet continuum can be divided basically into two types: the s type, i.e., rather discrete spectra, similar to stellar spectra, and the d type, i.e., spectra with smeared out, diffuse edges. According to their energy distribution, the s spectra resemble the spectra of quasars, whereas the d spectra are similar to the arms of spiral nebulae which usually consist of groups of bright stars. Arguments are presented which support the assumption that the ultraviolet continuum of the s-type objects arises from an unusual radiation emission, i.e., radiation of nonstellar origin, and that the d-type objects are stars with early-type spectra. The presence of such stars makes the spheroidal galaxies particularly noteworthy. (auth)

**30279** NOTE ON THE HYDROGEN DENSITY IN CLUSTERS OF GALAXIES. Karachentsev, I. D. (Astrophysical Observatory, Byurakan, USSR). Astrophysics (Engl. Transl.), 3: 46-7(Spring 1967).

Translated from Astrofizika, 3: 89-91(1967).

On the probable assumption that a cluster of galaxies is projected onto the quasi-stellar radio source 1116 + 12 the density of neutral and ionized hydrogen in the cluster is estimated. It is shown that one cannot explain the large virial masses of typical clusters of galaxies with the densities obtained. (auth)

**30280** THE POSITION OF THE LAYER OF INTERSTELLAR MATERIAL IN THE GALAXY M 31. Makarenko, E. N. (Astronomical Observatory, Odessa). Astrophysics (Engl. Transl.), 3: 48-53(Spring 1967).

Translated from Astrofizika, 3: 93-101(1967).

The possibility of an inclination of the gas and dust clouds to the plane of the spiral arms of M31 is suggested. It is shown that the spiral structure of the system of emission nebulae, according to previous observations, is best fitted by the assumption that $i_1 = 11°$ and $\theta_1 = 33.7°$ for the plane of the interstellar material, and $i_2 = 16°$ and $\theta_2 = 39.7°$ for the plane of the stellar system. The angle between the planes is $\varphi = 7.5°$ and the position angle of the line of intersection of the planes onto the plane of reference is $\psi = 21°$. This hypothesis explains the observed distribution of emission nebulae and some of the characteristics of maps showing the radio brightness in M31. Photometric effects which confirm the possible inclination of the interstellar component are discussed. (auth)

**30281** ON THE THEORY OF BARRED AND MAGELLANIC SPIRAL GALAXIES. Freeman, K. C.; Harrington, R. (Trinity Coll., Cambridge, Eng.). Bull. Astron., 3: 269-72(1968).

The properties of stellar orbits in barred spiral galaxies were studied in an attempt to understand the structural and kinematic features of these systems. Two of these features considered were: (1) the ring structures encircling the bars of SB(r) galaxies; and (2) the velocity field in the Magellanic barred spiral, NGC 4027. The rotation curve is shown. On the north side of the bar, the rotational velocity appears to decrease from 180 km/sec at R = 1.2 Kpc to 70 km/sec at R = 2.4 Kpc, and then increases again to 180 km/sec at R = 3.6 Kpc. There is no corresponding velocity feature on the south side of the bar. Surface photometry of the ring structures in SB(r) galaxies suggests that most of their mass lies in a roughly axisymmetric disk of stars, in which a smaller bar of stars is immersed. A disk + bar model is used to represent the gravitational field, and estimate from observation the likely range of parameters for the model. For the more slowly rotating models within this range of parameters, it was found that matter is trapped in an annulus around the bar. This trapping occurs because, in the slower rotators, there exists a sequence of highly stable, direct simply periodic orbits which encircle the bar (their periods are somewhat shorter than the rotation period of the bar). This trapping of matter in a ring-shaped region around the bar gives a natural explanation for the ring structures of SB(r) galaxies. The surface photometry of Magellanic systems like NGC 4027 again suggests that most of the mass lies in a disk + bar distribution, but that the centers of the disk and the bar are separated by about 0.5 to 1 Kpc. Such a model was used to represent the potential field in these galaxies and estimate the relevant parameters from spectroscopic and photometric observations. (BBB)

**30282** MASSES AND ANGULAR MOMENTA OF GALAXIES. Heidmann, N. (Univ. of Texas, Austin). Astrophys. Lett., 3: 153-9(May 1969).

The line widths of 48 galaxies measured at $\lambda = 21$ cm with the Nançay radiotelescope are used, together with other spectroscopic data, to obtain estimates of masses and angular momenta. The dependences upon galactic type of the mass-to-light ratios and of the mass-to-hydrogen content ratios are given and the masses are shown to be determined by two parameters: type and absolute luminosity. A relation between mass and angular momentum is found and, from it, it is possible to derive the density that the pregalactic gas clouds had when they reached their maximum extension. (auth)

**30283** GENERATION OF GALACTIC MAGNETIC FIELDS. Harrison, E. R. (Univ. of Massachusetts, Amherst). Astrophys. Lett., 3: 133-5(May 1969).

The viscous generator proposed by Browne and Biermann's thermal generator is shown to produce unacceptably weak magnetic fields in the Galaxy. This drawback does not necessarily apply to galactic magnetic fields which are "spin-generated" in the primordial fireball. (auth)

**30284** SURVEY OF THE ANTICENTRE REGION OF THE GALAXY AT A FREQUENCY OF 13.1 MHz. Andrew, B. H. (National Research Council, Ottawa). Mon. Notic. Roy. Astron. Soc., 143: 17-25(1969).

A survey of the anticentre region of the Galaxy at 13.1 MHz is described in which the method of aperture synthesis was employed to achieve a resolution of 2.7° × 6.3° at the zenith. The major inaccuracies of the survey were introduced by (a) the lack of adequate calibrating sources, and (b) grating sidelobes. The observations indicate that ionized hydrogen is concentrated in discrete regions in the galactic plane rather than in any general disc-like distribution. The nonthermal emissivity of space in the solar neighborhood is derived as $\sim 10^{-40}$ W ster$^{-1}$ Hz$^{-1}$ m$^{-3}$ at 13.1 MHz. (auth)(UK)

## Cosmology

*Refer also to abstracts 30369 and 30992.*

**30285** (N-69-20677) OUTLINE OF RELATIVISTIC COSMOLOGY FOR COSMIC GAMMA-RAY STUDIES. Stecker, F. W. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar. 1969. 14p. (NASA-TM-X-63486; X-641-69-89). CFSTI.

In the general theory of relativity, Einstein set out to identify the gravitational field with the geometry of space–time itself. He derived an equation using differential geometry which identified the curvature of space–time with the matter–energy density contained in it. The Einstein field equations were written in tensor form and take on four values, one time-like and three space-like. Gamma-ray fluxes emitted at large redshifts were calculated considering the effect of cosmological factors, and the metagalactic gamma-ray spectra from various high-energy interactions were evaluated. (auth) (STAR)

**30286** ELECTROMAGNETIC RADIATION OF THE EARTH AND OF THE UNIVERSE. Kanyo, Sandor. Fiz. Szemle, 19: 43-8(Feb. 1969). (In Hungarian).

Of the two distinct types of radiations reaching the Earth from the Universe, the electromagnetic radiation, with an energy of $0.85 \times 10^{16}$ eV/cm$^2$ is of much greater importance than the 1 eV/cm$^2$ corpuscular radiation flux. The atmosphere of the Earth disturbs greatly the study of these radiations. It is also of great importance in the development of the historical periods of astronomy which cover: observations in the visual range; observations in the radio wavelengths (both at the surface of the Earth), and observations and measurements in other wavelength ranges, such as infrared, ultraviolet, x radiation, $\gamma$ radiation, above the atmosphere. It is generally accepted that the gravitational field is responsible for the hierarchic arrangement of matter in the Universe; it created the stars, the galaxies, and the Metagalaxy. Several contradictory theories have been developed on the subject of the creation and death of celestial objects. These catastrophic processes are assumed to result in instabilities which induce resonances, leading to large emissions of matter and energy and to the ultimate annihilation of the object. These processes include novae, supernovae explosions, exploding galactic nuclei, quasars, the expanding Universe, etc. Although subatomic matter is probably available in large amounts, it can not be detected as yet. It may be expected that this problem will be clarified by $\gamma$-ray astronomy. (TTT)

**30287** COMPUTER SOLUTIONS OF THE GRAVITATIONAL N-BODY PROBLEM. Hohl, Frank (Langley Research Center, Hampton, Va.). Bull. Astron., 3: 227-40(1968).

A 2-dimensional model is used to perform computer experiments for a collisionless self-gravitating system. The gravitational field is obtained by solving the Poisson equation and the system is advanced stepwise in time. Results of some simple experiments containing up to 4000 particles or mass rods are given. The computer experiments were performed for systems which have an initially uniform circular distribution in x–y space and zero thermal velocity. The evolution of such systems is then studied for various values of initial solid body rotation. The initial conditions are obtained by using a random number generator which gives a nearly uniform distribution over a circular region of the x–y plane. The time development of the total kinetic energy of the 2000-particle systems investigated is shown. Only small oscillations occur for the balanced case. For the other cases the initially large oscillations in the kinetic energy are quickly damped as the systems approach an equilibrium state. The method described was also used to follow the evolution of initially very elongated distributions. Such distributions lead to spiral structure during the early stages of the evolution. However, the spiral structure is not stable and it quickly disappears as the system evolves. In addition to the computer experiments with the 2-dimensional model are results presented for 1-dimensional stellar systems. (BBB)

**30288** ANTIMATTER, QUASI-STELLAR OBJECTS, AND THE EVOLUTION OF GALAXIES. Alfven, Hannes (Royal Inst. of Tech., Stockholm); Elvius, Aina. Science, 164: 911-17 (May 23, 1969).

Astronomical observations indicate that there is a continuous developmental sequence from quasi-stellar objects, by way of N-galaxies, Seyfert galaxies, and radio galaxies, to ordinary galaxies. The sequence is interpreted as an evolutionary pathway. If this view is accepted it is found that the total energy released during the lifetime of a galaxy is so great that the most likely source is annihilation. The demand for symmetry in the Universe between koinomatter and antimatter indicates that there must be equal quantities of the two kinds of matter in every galaxy. From this it seems likely that a galaxy is born as an ambiplasma body, which releases a great deal of energy by annihilation. Separation of the ambiplasma into koinomatter and antimatter in reasonably stable configurations, and the burning out of the nonseparated ambiplasma, should be the main processes which govern the evolution from protogalaxies and quasi-stellar objects to ordinary galaxies. (auth)

**30289** MOMENTUM AND MASS DISTRIBUTION FUNCTIONS FOR NEWLY GENERATED COSMIC OBJECTS. Doroshkevich, A. G. Astrophysics (Engl. Transl.), 3: 84-9(Summer 1967). Translated from Astrofizika, 3: 175-88(1967).

The effect of the random character of initial density and velocity perturbations on the mass and specific momentum distribution functions for newly generated cosmic objects is examined. Simple assumptions are employed to deduce the mass and momentum distributions from the density and velocity distribution functions for the perturbations. The cosmological consequence of results are discussed, and the momentum distribution is compared with the observed rotational velocity distribution of stars. (auth)

**30290** EFFECT OF A CONSTANT MAGNETIC FIELD ON THE NEUTRON BETA DECAY RATE AND ITS ASTROPHYSICAL IMPLICATIONS. O'Connell, R. F.; Matese, J. J. (Louisiana State Univ., Baton Rouge). Nature (London), 222: 649-50(May 17, 1969).

The "cosmic laboratory" may be a source of very strong magnetic fields, and it has been suggested that fields as large as $10^{14}$ to $10^{16}$ G may exist in neutron stars. The possibility of a large primordial magnetic field has also been postulated; also that neutron stars and the dense early Universe may be ferromagnetic. A magnetic field effect which has often been ignored in astrophysical investigations is the effect on the rates of all elementary particle processes, and in pursuance of this idea the effect of a magnetic field on the $\beta$-decay rate of the neutron is examined. This a fundamental process in many astrophysical phenomena, and is very important with regard to He production in the "big bang" theory of the Universe. The analysis given should also be applicable to other elementary-particle processes. The effect of a magnetic field on elementary-particle rates will also have application to the cooling rate of neutron stars having large magnetic fields. (UK)

**30291** NONEQUILIBRIUM STATISTICAL MECHANICS AND GRAVITATIONAL INTERACTIONS. Prigogine, I.; Severne, G. (Univ., Libre, Brussels). Bull. Astron., 3: 273-97(1968).

The use of classical methods of the kinetic theory of gases to investigate the problems of stellar dynamics involving many degrees of freedom is commented on. A basic difficulty is that an essential property of a gas with usual short-range forces is its tendency to reach thermodynamic equilibrium, i.e., a uniform state of maximum entropy. The present state of the Universe is different from that predicted from equilibrium theory. A basic problem is, therefore, to determine to what extent the statistical mechanics and the thermodynamics developed for molecular systems continue to apply to gravitational systems. A compact derivation of evolution equations from the Liouville equation is given. With the perturbation expansion of the equation for the singlet distribution function, the customary description used for stellar systems is recalled: the so-called Boltzmann equation, and the binary collision model of Chandrasekhar. Also discussed are different generalized collision operators, currently still under investigation, which no longer introduce the divergence that vitiates Chandrasekhar's description and which therefore could provide a basis for a consistent statistical mechanical theory. Given their present state of advancement, it is premature to attempt comparative discussion of the models considered. However, these are in no way contradictory, but in fact constitute complementary approaches to the same problem. All the different effects separately considered above, can be simultaneously taken into account by means of a non-Markovian operator depending not only on the self-gravitational field but also on the rotation and collective effects. A realistic model might have to attain such a degree of complexity. (BBB)

**30292** INERTIA, RELATIVITY, AND COSMOLOGY. Horak, Z. (Technical Univ., Prague). Czech. J. Phys., 19: 703-20 (1969).

Starting with the idea that the inertia of bodies is a general property of all kinds of their potential energy, the author arrives at the two fundamental "megaphysical" equations ${}^0\Pi + c^2 = 0$, ${}^0\varphi = 0$ where ${}^0\Pi$ is the scalar gravitational potential due to the smoothed-out Universe, ${}^0\varphi$ is its electrostatic potential and c denotes the light velocity in vacuo. The first equation means physically that the cosmic potential ${}^0\Pi$ determines uniquely the velocity of light and consequently the pseudo-Euclidean geometry in an inertial frame, in the absence of local gravitational fields. This fact implies the validity of the law of inertia in a nonempty

Universe only, in full agreement with Mach's principle. If one adopts, for the cosmic potential, that of Seeliger, differing from the Newtonian potential by the exponential factor $\exp(-r/r_g)$, the first equation can be used to estimate the lower limit of the range $r_g$ of gravitational interaction within the limits ($10^{10}$ to $10^{12}$) light years. This suggests a steady-state model of the Universe consisting of an unlimited number of finite regions ("sub-universes") oscillating independently of each other. Such a superlarge-scale model Universe is in agreement with the observed galactic redshift, yet it fulfills the perfect cosmological principle. (auth)

**30293** FORMATION OF GALAXIES IN LEMAITRE'S UNIVERSE. Rawson-Harris, D. (Queen Elizabeth Coll., London). Mon. Notic. Roy. Astron. Soc., 143: 49-53(1969).

Using perturbation theory and Newtonian cosmology it is shown that a Lemaître model permits the formation of galaxies from a statistically probable fluctuation of the density. The characteristics of a suitable model are derived by an approximation. (auth) (UK)

**30294** INEVITABILITY OF A POINT SINGULARITY IN A ROTATING NEWTONIAN UNIVERSE. Pachner, J. (Univ. of Alberta, Edmonton). Phys. Lett., 29A: 147-8(Apr. 21, 1969).

On the basis of the equations deduced by Narlikar it is shown that a rotating incoherent matter whose behavior is governed by the laws of Newtonian mechanics must necessarily contract to a point singularity. (auth)

**30295** SUPERFLUIDITY AND SUPERCONDUCTIVITY IN THE UNIVERSE. Ginzburg, V. L. (Lebedev Inst. of Physics, Moscow). Usp. Fiz. Nauk, 97: 601-19(Apr. 1969). (In Russian).

A brief review is given on the aspects of existence and observations of superfluid and superconducting states in the Universe. The Bose–Einstein condensation, superfluidity and superconductivity, the possibility of superfluidity and superconductivity under cosmic conditions, superconductivity of dense degenerated plasma (white dwarfs and large planets), superfluidity and superconductivity of neutron stars, and superfluidity of the cosmological neutron "sea" are discussed. 40 references. (R.V.J.)

### *Planetary Phenomena*

*Refer to abstract 30819.*

## Atomic and Molecular Physics

*Refer also to abstract 31059.*

**30296** PROCEEDINGS OF THE ROBERT A. WELCH FOUNDATION CONFERENCES ON CHEMICAL RESEARCH. XI. RADIATION AND THE STRUCTURE OF MATTER, HOUSTON, TEXAS, DECEMBER 4–6, 1967. Milligan, W. O. (ed.). Proc. Robert A. Welch Found. Conf. Chem. Res., 11: 1-221(1968). (CONF-671219).

Separate abstracts were prepared for five of the eight papers included. The remaining three papers are not in the scope of NSA. (J.W.R.)

*For abstracts of individual papers see: 30306, 30332, 30461, 30661, and 31082.*

### *Atomic, Electron, Ion, and Molecular Beams and Their Reactions*

*Refer also to abstracts 28783, 28864, and 28932.*

**30297** (AD-681734) ANGULAR DEPENDENCE OF THE ENERGY SPECTRA OF SECONDARY IONS AT VARIOUS ANGLES OF EMISSION. Arifov, U. A.; Aliev, A. A.; Ayukhanov, A. Translated from Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, 11: No. 3, 41-7(1966). 18p. (FTD-MT-24-129-68). CFSTI.

An electrostatic analyzer previously described was used to study the dependence of the energy spectra of secondary ions from bombardment of metals by positive ions on the angle of incidence at various emission-angle values. Results are given, in particular, oscillograms showing the energy distribution and the angular dependence of the energy spectra at various angles of emission for secondary ions when a Mo target heated to 1800°K is bombarded by positive potassium or cesium ions with energy EO = 1000 eV. Some of the results are discussed and it is concluded that they can be explained from the viewpoint of paired collisions of the bombarding ions with a system of free atoms. (TSS) (USGRDR)

**30298** (UCRL-18347, pp 171-4) SECONDARY PARTICLE CONTRIBUTIONS TO THE BRAGG PEAK OF A HIGH-ENERGY HEAVY-ION BEAM. Curtis, Stanley B. (California Univ., Berkeley).

In the analysis of the depth-dose pattern produced by a high-energy heavy-ion beam, it is important to estimate the contribution from secondary particles produced by primary nuclear interactions. In particular, it is of interest to determine the effect of these secondaries on the Bragg peak of the beam. An upper limit to the effect of nuclear interactions on the spreading of the Bragg peak of a 300 MeV/nucleon neon-ion beam in water was estimated. A particular assumption was made for the emission frequency of fast secondary fragments in neon-oxygen interactions which weights the heavier fragments somewhat more than is indicated by the available cosmic ray data, so that a pessimistic value of the spreading is obtained. Usual assumptions, such as the straight-ahead approximation and the constancy of the interaction cross section with energy, were made, so that a hand calculation could be carried out. The results showed that an upper limit of the secondary contribution to the dose is 15% of the primary dose at the peak, and the upper limit to the percentage increase of the FWHM is also 15%. Thus, it appears that the Bragg peak will not be spread out appreciably by the presence of secondary particles from nuclear interactions in a high-energy neon-ion beam in water. (auth)

**30299** INTERACTIONS OF PARTICLES WITH SOLIDS. pp 231-305 of Atomic and Electron Physics: Atomic Interactions. Part B. Bederson, Benjamin; Fite, Wade L. (eds.). New York, Academic Press, Inc., 1968.

Experimental methods used in the study of particle interactions with solids are reviewed. One chapter deals with directed beams of atoms or ions incident on solid targets. Emphasis is on primary particle collisions most clearly described in terms of atomic collision processes. Penetration experiments and interactions with surface atoms are included. A chapter on electron interactions with solids deals particularly with electrons in the energy range from near zero to about 100 keV. Interactions with "atomistic" and crystalline solids are considered. Numerous references are included. (A.G.W.)

**30300** SCATTERING OF MONOENERGETIC ARGON BEAMS FROM HEATED PLATINUM: PLANAR TIME-OF-FLIGHT MEASUREMENTS. Moran, James P.; Wachman, Harold Y.; Trilling, Leon (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 12: 987-93(May 1969).

Time-of-flight measurements were made in the plane of incidence with initially monoenergetic argon beams (speeds $5.4 \times 10^4$ and $9.55 \times 10^4$ cm/sec) before and after reflection from heated platinum. The time-of-flight data were used to compute low-order moments of velocity distribution: relative number flux, momentum, and energy flux. Flux ratios yield mean speed, mean energy, and speed distribution as functions of angle of reflection. In all cases the mean speed and mean energy of the reflected stream show marked angular dependence, decreasing at a given incidence angle with increasing angle of reflection from the target normal. The mean tangential velocity of the reflected stream is close to that of the incident beam. Calculated incident beam speed distributions are near 0.1 whereas in the reflected streams values are closer to the Maxwellian limit 0.363. (auth)

**30301** COMPUTER SIMULATION OF SPACE-CHARGE FLOWS. Boers, Jack Edward. Ann Arbor, Mich., Univ. of Michigan, 1968. 285p.

Thesis.

Digital computer programs for the accurate determination of space-charge flows have been developed and are described for several types of electron gun configurations. The effects of space-charge and applied magnetic fields are taken into account and relativistic effects can be included. Direct particle–particle interaction effects are ignored, although dc thermal effects are given a brief treatment. The computer programs are written in the IBM-7090 FORTRAN programming language and require from four to 15 minutes to execute on an IBM-7090 digital computer. Individual sections of the programs, e.g., trajectory calculations, field evaluations, etc., are shown to be generally within 0.1 percent of theoretical predictions. The overall results are generally within four percent of either theory or experiment. The electrostatic and magnetic convergence and focusing of axially symmetric beams are discussed in detail. It is shown that the convergence of an electron gun can be significantly improved through the application of a strong axial magnetic field before the electrostatic beam minimum is reached. Immersed flow, with significant magnetic flux linking the cathode, is shown to produce a very laminar beam that could be of use for irradiation, thin-film deposition, and implantation applications. A program for the

analysis of magnetron injection guns is also described. Significant electron cycloiding in the cathode electrode region is shown to cause stability in the cathode current distribution. The successful simulation of a 22.5-degree half-angle cone cathode demonstrates the potential usefulness of the program. The importance of cathode edge effects is shown for a crossed electric and magnetic electron gun configuration. The insulating gaps at the edges of the cathode are shown to produce significant deviations from uniform emission from the cathode. (Disser. Abstr.)

**30302** ANGULAR DEPENDENCES IN ELECTRON-EXCITED AUGER EMISSION. Harris, L. A. (General Electric Research and Development Center, Schenectady, N. Y.). Surface Sci., 15: 77-93(May 1969).

An experimental study of the variations of Auger emission with primary beam angle and angle of emission has verified that the observation depth is limited by the scattering of the low-energy emitted electrons, and that by varying the angle of observation, surface atoms can be distinguished from those distributed more deeply within the specimen. An idealized model of the system is shown to be useful in predicting most of the principal features observed. (auth)

**30303** STOPPING BY ELASTIC COLLISIONS OF KILOVOLT IONS IN GASEOUS MIXTURES AND AMORPHOUS COMPOUNDS. Baroody, E. M. (Battelle Memorial Inst., Columbus, Ohio). J. Appl. Phys., 40: 2555-9(May 1969).

Calculations are made of spatial moments $\langle z^n \rangle$ for particles from a plane source brought to rest in an infinite medium of randomly located target atoms of several kinds. The relationships obtained are illustrated by the determination of the mean penetration $\langle z \rangle$ and the straggling parameter $\Omega = (\langle z^2 \rangle - \langle z \rangle^2)^{1/2} / \langle z \rangle$ for kilovolt $^{125}Xe$ ions in $WO_3$. Results compare favorably with published experimental data. (auth)

## *Atomic and Molecular Properties*

*Refer also to abstracts 28817, 30332, 30336, 30339, 30355, and 30356.*

**30304** RADIATIVE LIFETIMES OF ULTRAVIOLET TRANSITIONS OF ARGON II. Matilsky, Terry A.; Hesser, James E. (Princeton Univ. Observatory, N. J.). J. Opt. Soc. Amer., 59: 579-82(May 1969).

The electron-excitation, phase-shift method of Lawrence has been applied to the determination of radiative lifetimes of Ar II transitions. The measured levels, which are primarily those of $4p\ ^2S$, $^2P$, $^4D$, were studied using transitions in the region from 1900 to 4500 Å. The Ar II lifetimes measured ranged from 1.2 to 10.6 nsec and involve a number of levels in which configuration interaction is present. (auth)

**30305** ABSORPTION SPECTRUM OF $NpO_2^{2+}$ IN $Cs_2UO_2Cl_4$. Stafsudd, O. M.; Leung, A. F.; Wong, Eugene Y. (Univ. of California, Los Angeles). Phys. Rev., 180: 339-43(Apr. 10, 1969).

The absorption spectrum of $NpO_2^{2+}$ in $Cs_2UO_2Cl_4$ was observed. Five pure electronic levels at 6880, 13277, 15426, 17478, and 19358 $cm^{-1}$ were identified through the vibronic transitions. The ground state and the energy level at 6880 $cm^{-1}$ belong to the $5f^1$ configuration. However, the rest of the observed energy levels do not belong to the $5f^1$ configuration. Most likely, they come from an excited configuration which has a hole in the Np—O bond and two electrons in the nonbonding 5f shell. (auth)

**30306** NEAR SYMMETRY AND MODEL STRUCTURES. Eyring, Henry (Univ. of Utah, Salt Lake City). Proc. Robert A. Welch Found. Conf. Chem. Res., 11: 7-28(1968).

From 11th Robert A. Welch Foundation Conference on Chemical Research, Radiation, and the Structure of Matter, Houston, Tex. See CONF-671219.

The Bohr theory of the atom is sketched as the basis for symmetry considerations in the structure of matter. Brief consideration is then given to diatomic molecules and symmetry, nuclear structure, parity, molecular asymmetry, and symmetry implications for photon structure. In a lengthy discussion following presentation of the paper, examples of symmetry, near symmetry, and asymmetry in molecular biology (in relation to theories of the origin of life), atomic structure, and the universe were considered. (A.G.W.)

**30307** QUANTUM-MECHANICAL STUDY OF THE $F^1\Pi_u$ AND $F^3\Pi_u$ STATES OF $He_2$. Gupta, B. K.; Matsen, F. A. (Univ. of Texas, Austin). J. Chem. Phys., 50: 3797-3803 (May 1, 1969).

A quantum-mechanical study of the two states, $F^1\Pi_u$ and $f^3\Pi_u$ of the helium molecule is made using the valence-bond method with configuration interaction. A procedure for constructing valence-bond functions that give good energy values in the entire range of internuclear distances is described. The wave function used for each calculation is a 49-term function of the generalized valence-bond type. The basis for the $^1\Pi_u$ state is a set of Slater-type orbitals, while the one for the $^3\Pi_u$ state contains both Slater and elliptic-type orbitals. Vibrational levels and spectroscopic constants are calculated and the results suggest the existence of more vibrational levels than have hitherto been observed for both states, the spectroscopic constants being in excellent agreement with experiment. The existence of maxima in the potential curves of both states is confirmed to be due to the avoidance of crossings of curves of the same group-theoretical species. (auth)

**30308** NEW SEALED ATOMS-IN-MOLECULES THEORY FOR PREDICTING DIATOMIC POTENTIAL-ENERGY CURVES. III. REFINED APPLICATIONS TO THE $X^1\Sigma_g^+$ AND $E^1\Sigma_g^+$ STATES of $H_2$. Ellison, Frank O.; Slezak, Jane A. (Univ. of Pittsburgh). J. Chem. Phys., 50: 3942-6(May 1, 1969).

Scaled atoms-in-molecules theory is applied to the ground $X^1\Sigma_g^+$ and first excited $E^1\Sigma_g^+$ states of $H_2$. Five basis functions are included, corresponding to 1s H + 1s H, $^1S\ H^- + H^+$, 1s H + 2s H, 1s H + $2p_0$H, and $2p_+$ H + $2p_-$ H. Variational scaling parameters are introduced into the A- and B-atom eigenfunctions comprising each basis function; the ground- and first-excited-state energy roots of the secular determinant are independently minimized with respect to these scaling parameters. For computing interatomic contributions to the energy and overlap matrix elements, three different approximations to the $^1S\ H^-$ ground-state eigenfunction are used. Scaled atoms-in-molecules theory in this approximation yields an $H_2$ ground-state energy 6.5 kcal/mole above the exact result. An $E^1\Sigma_g^+$ excited-state curve is obtained with the proper double minimum; the predicted energy at the outer minimum is almost exact, and at the inner minimum it is about 7.5 kcal/mole too high. (auth)

**30309** A NEW VARIATIONAL PRINCIPLE FOR THE LAMB SHIFT OF THE LEVELS OF A MANY-ELECTRON ATOM. Dmitriev, Yu. Yu.; Labzowskii, L. N. (Leningrad State Univ.). Phys. Lett., 29A: 153-4(Apr. 21, 1969).

The whole relativistic energy shift of a many-electron atom consists of two parts, of which one is Bethe's logarithm or "average excitation energy" and the other is an expectation value of some effective potential V. A new variational method is proposed for the calculation of the average excitation energy. Use of the method for the ground states of the hydrogen and helium atoms resulted in values of 2.66 and 3.12, respectively. (A.G.W.)

**30310** TABLES OF SPECTRAL LINES OF NEUTRAL AND IONIZED ATOMS. Striganov, A. R.; Sventitskii, N. S. New York, IFI/Plenum Data Corporation, 1968. 908p.

Translation of Tablitsy Spektral'nykh Linii Neitral'nykh i Ionizovannykh Atomov.

Lines of the emission spectra of 22 of the elements most frequently encountered in plasma investigations are tabulated. For each spectral line, the wavelength, intensity, and classification are listed. Spectra of each neutral atom and several of its ions are given for all the gaseous elements except Rn, for all the alkali metals except Rb and Fr, and for C, Mg, Al, Si, Ca, Ti, Fe, and Cu. (A.G.W.)

**30311** POTENTIAL ENERGY SURFACES FOR LINEAR $HeH_2^{++}$. Zetik, Donald Frank. Austin, Tex., Univ. of Texas, 1968. 124p.

Thesis.

Ground state potential energy surfaces are presented for linear $^1\Sigma^+ HeH_2^{++}$. They are based on computations with a sixteen-term, configuration-interaction wave function. The terms were constructed in the valence-bond formulation from a basis set of 1s Gaussian orbitals. The variation principle was employed to optimize the linear and nonlinear parameters of the wave function. This optimization was performed for each computed nuclear geometry. (Disser. Abstr.) (TSS)

**30312** THE EXACT PROPAGATOR FOR AN ELECTRON IN A UNIFORM ELECTRIC FIELD AND ITS APPLICATION TO STARK EFFECT CALCULATIONS. Lukes, T.; Somaratna, K. T. S. (University Coll., Cardiff, Wales). J. Phys., C (London), 2: 586-93(Apr. 1969).

A calculation is presented of the single-particle propagator for a free electron in a uniform electric field. In its time-dependent form this takes simple closed forms in both momentum and configuration space. Series expansions for the Fourier transform of the configuration-space propagator are given. The latter is used to make a calculation of the electric-field dependence of the (approximate) bound state of the delta-function potential. A variational method suitable for general potentials is also given. (auth) (UK)

**30313** EXPERIMENTAL VALUE OF $\Delta E_H - S_H$ IN HYDROGEN. Shyn, T. W.; Williams, W. L.; Robiscoe, R. T.; Rebane, T. (Harrison M. Randall Lab. of Physics, Ann Arbor, Mich.). Phys. Rev. Lett., 22: 1273-5(June 16, 1969).

The $2^2S_{\frac{1}{2}} - 2^2P_{\frac{1}{2}}$ separation, $\Delta E_H - S_H$, in atomic hydrogen was measured by an atomic-beam rf method. It was found that $\Delta E_H - S_H = 9911.213 \pm 0.058$ MHz. The quoted error is 1 average deviation from the mean for 115 line centers. (auth)

**30314** DECAY OF THE $(2s^22p)^2P$ COMPOUND STATE IN HELIUM BY TWO-ELECTRON EMISSION. Burrow, P. D.; Schulz, G. J. (Yale Univ., New Haven). Phys. Rev. Lett., 22: 1271-3(June 16, 1969).

Compound states of atoms are known to decay by the emission of a single electron into many states lying at lower energies. Compound states associated with doubly excited states lie at energies above the ionization potential, and therefore the decay into an ion by the emission of two electrons is energetically possible. This paper presents evidence for such a two-electron decay in the case of the $(2s^22p)^2P$ compound state of helium, which derives from the $(2s^2)^1S$ atomic state. (auth)

**30315** MASS SPECTROMETRIC EVIDENCE FOR THE EXISTENCE OF THE $He_2H^+$ ION. Veatch, G. E.; Oskam, H. J. (Univ. of Minnesota, Minneapolis). Phys. Lett., 28A: 740-1 (Mar. 10, 1969).

Studies of the ionic composition of room-temperature plasmas produced in helium–hydrogen mixtures have shown the existence of the $He_2H^+$ ion. (auth)

**30316** ON THE ACCURACY OF HARTREE–FOCK WAVE FUNCTIONS. Newman, D. J. (Queen Mary Coll., London); Curtis, M. M. Chem. Phys. Lett., 3: 158-60(Mar. 1969).

It is shown, by comparison with experiment, that the use of explicit angular momentum coupling in Hartree–Fock solutions for rare earth ions can lead to inaccurate 4f radial wave functions because of the neglect of intershell correlation effects. (auth)

## *Positronium, Muonium, and Mesic Atoms and Molecules*

*Refer also to abstracts 30480 and 31032.*

**30317** INVESTIGATION OF MUONIUM DEPOLARIZATION PROCESSES IN GERMANIUM SINGLE CRYSTALS. Andrianov, D. G.; Myasishcheva, G. G.; Obukhov, Yu. V.; Roganov, V. S.; Firsov, V. G.; Fistul, V. I. Zh. Eksp. Teor. Fiz., 56: 1195-8 (Apr. 1969). (In Russian).

The dependence of $\mu^+$-meson polarization on temperature was studied in germanium single crystals of various degrees of alloying. A precession has been observed at a frequency that corresponds to atomic muonium with a decay lifetime of $0.16 \pm 0.07$ $\mu$sec. Possible mechanisms of interaction of muonium in media of various electron density are discussed. (auth)

**30318** THEORY OF MUONIUM MECHANISM OF $\mu^+$ MESON DEPOLARIZATION IN MEDIA WITH TENSOR RELAXATION OF THE MUONIUM ELECTRON SPIN. Ivanter, I. G. Zh. Eksp. Teor. Fiz., 56: 1419-31(Apr. 1969). (In Russian).

A theory of depolarization in media is developed in which the tensor nature of the relaxation rate is related to the presence of an external field. A new effect is predicted, which should occur in semiconductors. Its essence is that slow precession in a superstrong magnetic field is insensitive to the damping magnitude and hence it should be possible to observe muonium under conditions in which direct methods would be useless. Formulas are obtained for polarization at a moment that is infinite with respect to the time of the chemical reaction. Formulas are also derived for the time dependence of the polarization in a number of limiting cases. In particular, formulas are obtained for the case when muonium precession beats in a magnetic field, recently discovered, can be observed. (auth)

**30319** POSITRON THERMALIZATION IN A PLASMA OF CONDUCTION ELECTRONS IN A METAL. Brouers, Francois (Univ., Liege). Bull. Cl. Sci., Acad. Roy. Belg., 54: 895-902 (1968). (In French).

It is shown that the thermalization time for a positron in the electron plasma of a metal, calculated by use of the effective potential in linear response theory to describe the electron–positron interaction, is clearly larger than that calculated in a static approximation by Lee–Whiting. For aluminum the process of thermalization is nearly three times as rapid as the process of annihilation. It seems then, that in metals the positron is always thermalized before its annihilation. (tr-auth)

**30320** INVESTIGATION OF $\mu^+$ MESON DEPOLARIZATION IN SCINTILLATION PLASTICS IN VARIOUSLY ORIENTED MAGNETIC FIELDS. Myasishcheva, G. G.; Obukhov, Yu. V.; Roganov, V. S.; Firsov, V. G. Zh. Eksp. Teor. Fiz., 56: 1199-1203(Apr. 1969). (In Russian).

The dependence of $\mu^+$-meson polarization on the field strength of a longitudinal, transverse, or 45° (135°) magnetic field was studied experimentally in samples of a characteristic structure. A qualitative description is proposed of the behavior of muonium interacting with substances capable of forming molecular and radical products along independent channels. The results are analyzed within the framework of the concept of chemical interactions of muonium. (auth)

## *Collision Phenomena*

**30321** (AD-683795) MEASUREMENT AND ANALYSIS OF OPTICAL EMISSIONS RESULTING FROM 20- TO 100 keV PROTON–NITROGEN COLLISIONS. Gardiner, Harold A. B. (Utah State Univ., Logan. Electro-Dynamics Labs.). May 1, 1968. Contract AF19(628)-5916. 185p. (AFCRL-68-267). CFSTI.

Absolute cross sections for excitation of the $N_2^+$ first negative bands in collisions of 20- to 100-keV protons with $N_2$ were measured under single conditions. On the basis of a charge-exchange model that predicted the observed variation of intensity with pressure, emission cross sections for the (0,0) 3914-Å $N_2^+$ first negative band and the (0,2) 3805-Å $N_2$ second positive band were obtained for hydrogen-atom impact and the sum of the cross sections for electron capture and loss were found for hydrogenic particles traversing $N_2$. An upper limit of $4 \times 10^{20}$ sq cm has been established for the cross section for 100-keV proton impact excitation of the second positive band. A critical analysis shows that the intensity-versus-pressure curve for this band provides a sensitive means of detecting secondary processes in this beam experiment. Cross sections for production of $H_\beta$ radiation, determined from observations made at a point 30.5 cm from the collision chamber entrance, were found to be more than a factor of three larger than those reported by previous investigators. The cross section for collisional quenching of a 100-keV hydrogen atom from the n = 4 level was estimated at $3 \times 10^{16}$ cm$^2$. (auth) (USGRDR)

**30322** (LA-3972) TRANSFORMATIONS FROM BARYCENTRIC TO LABORATORY COORDINATES FOR TWO- AND THREE-BODY SCATTERING EVENTS. Maier II, William B. (Los Alamos Scientific Lab., N. Mex.). Mar. 1968. Contract W-7405-eng-36. 53p. Dep. CFSTI.

Formulas that transform differential cross sections from the barycentric, or center-of-mass, coordinate system to the laboratory coordinate system are derived and presented. Methods for obtaining the laboratory kinetic-energy distributions of reaction products from the differential cross sections, $\sigma'$, in the barycentric system are given. These discussions pertain to two types of reactions: those, such as (1) $a + X \rightarrow b + Y + Q$, which produce two particles, and those, such as (2) $a + X \rightarrow b_1 + b_2 + b_3 + Q$, which produce three particles, where Q is the energy released by the reaction. These two reactions are treated explicitly for two simple forms of $\sigma'$, namely $\sigma' \propto 1/\sin\theta^*$ and $\sigma'$ = constant, where $\theta^*$ is the scattering angle in the barycentric system; for these cases the distributions of the reaction products over kinetic energy and scattering angle in the laboratory coordinate system are plotted. A few incidental results are mentioned. For a given value of Q, the laboratory kinetic energy of a particle produced by reaction (1) is analytically determined by the laboratory scattering angle, $\theta$; particles produced by reaction (2) and scattered at an angle $\theta$ have a distribution of laboratory kinetic energies that depends on $\sigma'$. If the cross section for a reaction that produces three bodies is proportional to the volume of momentum space available to the products, then the final kinetic energy tends to be equipartitioned among the reaction products, provided that the products' masses are not too different. If one of the products, $b_3$, of reaction (2) is much less massive than the others, then the separation of $b_1$ and $b_2$ approximates a two-particle disintegration in which the total kinetic energy is not fixed. Simultaneous measurements of the laboratory kinetic energy and angular distributions of one type of secondary particle produced in reaction (1) are sufficient to determine the dependence of $\sigma'$ on $\theta^*$ and Q. (auth)

**30323** (N-69-22168) NUMERICAL CALCULATION OF ELECTRON-ATOM EXCITATION AND IONIZATION RATES USING GRYZINSKI CROSS SECTIONS. Goldstein, R. (Jet Propulsion Lab., Pasadena, Calif.). Mar. 1, 1969. Contract NAS7-100. 10p. (NASA-CR-100546; JPL-TR-32-1372). CFSTI.

Gryzinski classical cross sections and Maxwellian electron distributions were used to obtain a simple analytical expression that

represents the calculations within ±5% over the range of electron temperatures and atomic parameters considered to be physically most important. Transition rates calculated from a linear approximation to the cross sections showed less agreement with the exact values than this analytical expression. (auth) (STAR)

**30324** (ORNL-TM-2546) STUDIES OF NEGATIVE ION–MOLECULE REACTIONS IN THE ENERGY REGION FROM ZERO TO THREE ELECTRON VOLTS. Stockdale, J. A. D.; Compton, R. N.; Reinhardt, P. W. (Oak Ridge National Lab., Tenn.). May 1969. Contract W-7405-eng-26. 155p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The dissociative attachment of electrons to molecules ($e + AX \rightarrow A^- + X$) was used to produce negative ions in the energy region from 0 to near 3 eV through impact of monoenergetic electrons on various molecular gases located in the source region of a time-of-flight mass spectrometer. After being produced in a short interval of time these primary ions were allowed to react for a controlled period with the molecular gas or gases present in the field-free reaction region. Sampling and measurement of both primary and secondary product ions as a function of the reaction time yielded the rate of the reaction and knowledge of the primary-ion velocity permitted calculation of the reaction cross section. Cross sections of the reactions $H^- + H_2O \rightarrow OH^- + H_2$, $D^- + D_2O \rightarrow OD^- + D_2$, and $O^- + NO_2 \rightarrow NO_2^- + O$ have been measured at a number of points in the energy region from 0 to 3 eV and the cross sections or rates of various other reactions have been measured at a single primary ion energy. These results are compared with theoretical predictions. New information has been obtained on the products of dissociative electron attachment to $NO_2$, $NH_3$, $ND_3$, $SO_2$, and HCOOH. These results are presented in shortened form here and reference is made to publications in the open literature where they are discussed more fully. Some results on the use of HCl gas as a scavenger for low-energy electrons are presented. (auth)

**30325** PRODUCTION OF METASTABLE HYDROGEN ATOMS BY ELECTRON CAPTURE OF PROTONS IN A THICK HELIUM TARGET. Dose, V. (Queen's Univ., Belfast). Helv. Phys. Acta, 42: 539-41(May 16, 1969).

The production of metastable hydrogen atoms by electron capture of protons in a thick helium target is calculated in a three-state approximation. Theoretical cross sections are used for the processes of electron loss from and collisional de-excitation of the excited hydrogen atom; experimental data are used for the other cross sections involved. (auth)

**30326** CHARGE TRANSFER AND VIBRATIONAL EXCITATIONS IN $H_2^+$–$H_2$ COLLISIONS. Bates, D. R.; Reid, R. H. G. (Queen's Univ., Belfast). Proc. Roy. Soc. (London), Ser. A, 310: 1-20(Apr. 29, 1969).

By using the impact-parameter formulation $H_2^+(v_0') - H_2(v_0'')$, collisions leading to $H_2^+(v') - H_2(v'')$ or to $H_2(v'') - H_2^+(v')$ are treated. It is assumed that the ion and the molecule are in the ground electronic state, so that only two electronic states of the complex are involved. The electronic interaction is evaluated by a simple extension of the method of Firsov (1951). If spherical symmetry is assumed, the problem effectively reduces to solving a set of coupled first-order differential equations, the coefficients of which depend on the $H_2^+$–$H_2$ vibrational overlap integrals. Cross-section curves for vibrational excitation with (X) and without (D) charge transfer are presented. If the impact velocity V is low, corresponding D and X cross sections are about equal, but in the region of high V the former tends to fall off more rapidly than the latter. The total charge-transfer cross section in $H_2^+(0) - H_2(0)$ collisions, $Q^X(00 \rightarrow \Sigma|V)$ is calculated. As V is increased from zero $Q^X(0\,0 \rightarrow \Sigma|V)$ first shows the slow fall off characteristic of symmetrical resonance charge transfer; but it reaches a minimum when V is near $1 \times 10^{-1}$ au, then rises and passes through a maximum. This behavior arises from the increase in the relative contribution to charge transfer from the inelastic collisions. To facilitate comparison with experiment a study was also made of charge transfer when the $H_2^+$ ions are distributed among the vibrational levels as they would be if they were produced by the impact of fast electrons on $H_2$ molecules. The calculations on the weighted mean total charge-transfer cross section $\overline{Q}^X(\Sigma|V)$ are confined to the low- and high-velocity limits. However, they are sufficient to indicate that $Q^X(00 \rightarrow \Sigma|V)$ and $\overline{Q}^X(\Sigma|V)$ are not markedly different. The predicted form of the cross-section curve is consistent with the laboratory data available. (auth) (UK)

**30327** IODINE NEGATIVE ION PRODUCTION (1 TO 4.5 MeV). BY ELECTRON ATTACHMENT IN GASES. Wittkower, A. B.; Ryding, G.; Rose, P. H. (High Voltage Engineering Corp., Burlington, Mass.). Phys. Lett., 29B: 97-9(Apr. 14, 1969).

The yields of negative iodine ions were measured when $I^+$ ions were passed through $H_2$, He, $O_2$, Ar, and Kr gases at energies between 1 and 4.5 MeV. (auth)

**30328** SHOCK-WAVE OBSERVATIONS OF RATE CONSTANTS FOR ATOMIC HYDROGEN RECOMBINATION FROM 2500 TO 7000°K: COLLISIONAL STABILIZATION BY EXCHANGE OF HYDROGEN ATOMS. Hurle, I. R.; Jones, A.; Rosenfeld, J. L. J. (Thornton Research Centre, Chester, Eng.). Proc. Roy. Soc. (London), Ser. A, 310: 253-76(May 6, 1969).

Rate constants for the recombination of atomic hydrogen with hydrogen molecules, hydrogen atoms, and argon atoms as the third bodies are presented in functional form for the range of temperatures from about 2500 to 7000°K and are critically compared with the results of other workers. The rate constants are evaluated from detailed analyses of spectrum-line reversal measurements of the fall in temperature accompanying dissociation behind shock waves in gas mixtures containing 20, 40, 50, and 60% of hydrogen in argon. The rate constants for recombination with hydrogen molecules ($k_{-1}$) and argon atoms ($k_{-3}$) fit the equations $\log_{10} k_{-1} = 15.243 - 1.95 \times 10^{-4} T$ cm$^6$ mole$^{-2}$ sec$^{-1}$, and $\log_{10} k_{-3} = 15.787 - 2.75 \times 10^{-4} T$ cm$^6$ mole$^{-2}$ sec$^{-1}$, with a standard deviation of 0.193 in $\log_{10} k_{-1}$. The rate constant for recombination with hydrogen atoms is about ten times larger than these values at 3000°K and shows a steep inverse dependence on temperature ($\sim T^{-6}$) above 4000°K. Below this temperature the power of this dependence decreases rapidly and there is strong evidence that the value of this rate constant has a maximum around 3000°K. This behavior is interpreted on the basis of a process of collisional stabilization by atom exchange, requiring an activation energy around 8 kcal mole$^{-1}$ and taking place under conditions of vibrational adiabaticity. The overall results indicate that the assumption of equality between the equilibrium constant and the ratio of the rate constants for dissociation and recombination is valid throughout the region of nonequilibrium dissociation and at all temperatures in the shock waves examined. (auth) (UK)

**30329** EXCITATION OF NEON ATOMS BY ELECTRON IMPACT. Sharpton, Francis Arthur. Norman, Okla., Univ. of Oklahoma, 1968. 103p.

Thesis.

The cross sections of over 250 spectral lines of neon have been measured by the optical method. The estimated accuracy of the absolute experimental measurements was generally within a 20 percent limit, at least for the stronger lines. The approximate wavelength interval extends from 3300 to 12,000 Å. From the measured values determined for an incident-electron energy of 100 eV of all 30 transitions belonging to the $2p \rightarrow 1s$ series, the apparent cross sections of the ten 2p levels have been obtained. The excitation functions of the ten 2p levels are plotted from onset to 200 eV. The cross sections of the significant spectral lines belonging to the series $ns \rightarrow 2p$ and $nd \rightarrow 2p$ are tabulated. In those few cases where the cross sections could not be determined experimentally, the values are estimated by using theoretical transition probabilities. The final results yield the total cascade contribution into the 2p family for an incident-electron energy of 100 eV. These show the cascade contribution to vary from eight percent for the $2p_1$ level to 67 percent for the $2p_{10}$ level. Comparisons are made between the experimental results and corresponding theoretical calculations obtained by employing the Born–Ochkur approximation. The excitation functions of both the s and d levels are also presented. Similarities in these curves to those of helium are noted. Thus, the excitation functions of the pure triplet states are characterized by sharp peaks and fast declining tails, while those corresponding to levels connected to the ground state by optically allowed transitions have very broad, nearly flat peaks. An estimate was made of the contribution to the apparent cross sections of the 2s levels due to cascade from the 3p family. Theoretical transition probabilities were used to find the cross sections of the $3p \rightarrow 2s$ transitions from experimentally measured cross sections of spectral lines belonging to the $3p \rightarrow 1s$ family. The excitation cross sections of the 2s states determined in this manner are very sensitive to the inaccuracy of the wave functions employed to determine the transition probabilities. Therefore, the final results represent only qualitative estimates. (Disser. Abstr.)

**30330** EXCITATION OF HELIUM BY PROTONS IN THE 1 TO 150-keV REGION. van den Bos, J.; Winter, G. J.; De Heer, F. J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 40: 357-84(1968).

Absolute cross sections have been determined for excitation of helium from the ground state to $n^1S$, $n^1D(n = 3, 4, 5, 6)$ and $n^1P$ $(n = 3, 4, 5)$ states by the impact of protons in the 1- to 150-keV energy region. Low target gas pressures were used to avoid secondary processes. The cross sections show a similar dependence on impact energy for different levels of a spectral series except at low energies. Generally more than one maximum is found. The experimental results are compared with those of other groups, which have measured up to 1000 keV, and with Bora and distortion calculations. For $^1P$ levels the Born approximation

starts to hold at about 300 keV. For $3^1P$ the distortion approximation agrees well with experiment above 30 keV. For $^1S$ and $^1D$ levels there is a large discrepancy between the experimental absolute cross sections of different groups. In the comparison with the Born approximation, when the relative energy dependence of the cross section is considered, the experimental cross sections become larger than the Born ones below an impact energy of about 1000 keV. The polarization of the collision-induced radiation has been determined for $^1P-^1S$ and $^1D-^1P$ transitions. A maximum value of the polarization is found at an impact energy for which the excitation cross section also displays a maximum. The experimental polarization differs from theory. (auth)

**30331** EMISSION CROSS SECTIONS OF THE FIRST NEGATIVE BAND SYSTEM OF $N_2$ BY ELECTRON IMPACT. Aarts, J. F. M.; De Heer, F. J.; Vroom, D. A. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 40: 197-206(1968).

Cross sections have been measured for the emission of the first negative band system of $N_2$ when excited by electrons in the energy range of 0.1 to 6 keV. In particular the v'' progressions with the v' = 0 and 1 levels have been investigated. The emission cross sections can be analyzed by application of the Bethe–Born approximation. A relatively strong contribution from collision-induced dipole transitions is found in the excitation process. The energy behavior of all vibrations is the same. The total emission cross sections of both v'' progressions account for 12.5% of the total ionization cross sections of $N_2$. Comparison is made with existing electron, proton, and photon impact data. (auth)

**30332** MODIFICATION OF ATOMS BY A RADIATION BATH. Kastler, Alfred (Univ., Paris). Proc. Robert A. Welch Found. Conf. Chem. Res., 11: 153-63(1968).

From 11th Robert A. Welch Foundation Conference on Chemical Research, Radiation, and the Structure of Matter, Houston, Tex. See CONF-671219.

By putting atoms into nonresonant radiation fields of the rf range or the optical range, effects that can be attributed to virtual absorption of photons can be obtained. The properties of the atoms can be altered in this way. Two experiments performed by Cohen–Tannoudji using $^{199}Hg$ are described: One shows that through the effect of a rf field the Zeeman splitting in a steady magnetic field can be suppressed; the other shows that by the action of a light beam a Zeeman splitting without magnetic field can be obtained. The effects obtained here with ordinary light sources can be increased by use of lasers. (A.G.W.)

**30333** ATOMIC AND ELECTRON PHYSICS: ATOMIC INTERACTIONS. PART B. Bederson, Benjamin; Fite, Wade L. (eds.). Methods of Experimental Physics. Volume 7. New York, Academic Press, Inc., 1968. 385p. $17.00.

A separate abstract was prepared for each of two parts of this book. Four other parts deal with optical pumping, swarms, shock tubes, and flame kinetic studies. (A.G.W.)

*For abstracts of individual sections see: 30299 and 30532.*

**30334** ION–NEUTRAL EXPERIMENTS. pp 361-486 of Atomic and Electron Physics: Atomic Interactions. Part A. Bederson, Benjamin; Fite, Wade L. (eds.). New York, Academic Press, Inc., 1968.

Experimental techniques for investigating elastic and inelastic collisions between gaseous ions and neutral atoms and molecules are reviewed. The first chapter, which covers the energy range from about $10^{-3}$ to roughly 1 eV, includes techniques based on mass spectrometers, ion drift tubes, and ion cyclotron resonance. In a chapter on single-beam experiments, considerable attention is given to apparatus used in making pressure measurements in the range $10^{-2}$ to $10^{-5}$ torr and to various devices used in absolute measurements of beam intensities. A third chapter covers use of merging beams for measuring resonant charge-transfer cross sections. Single-source and double-source systems are described. Numerous references are included. (A.G.W.)

**30335** NEUTRAL–NEUTRAL INTERACTIONS. pp 227-360 of Atomic and Electron Physics: Atomic Interactions. Part A. Bederson, Benjamin; Fite, Wade L. (eds.). New York, Academic Press, Inc., 1968.

Experimental techniques used in study of atomic- and molecular-beam scattering are reviewed. A discussion of measurements at thermal energies centers about an idealized crossed-beam scattering experiment. A second chapter deals with energies in the approximate range of 100 to 2000 eV. Measurement of integral and differential cross sections for elastic and inelastic scattering is described, and use of these results to obtain intermolecular potentials is discussed. (A.G.W.)

**30336** PHOTON INTERACTIONS WITH PARTICLES. pp 117-226 of Atomic and Electron Physics: Atomic Interactions. Part A. Bederson, Benjamin; Fite, Wade L. (eds.). New York, Academic Press, Inc., 1968.

Experimental methods used in study of photon interactions with particles are reviewed with emphasis on the most recent methods. Four sections by different authors cover the following: (1) transition probabilities for allowed and forbidden lines; lifetimes of excited states; (2) absorption, photo-ionization, and scattering cross sections; (3) photodetachment; (4) ionization, detachment, and dissociation by electric and magnetic fields. Numerous references are included. (A.G.W.)

**30337** ELECTRON–ATOM INTERACTIONS. pp 1-115 of Atomic and Electron Physics: Atomic Interactions. Part A. Bederson, Benjamin; Fite, Wade L. (eds.). New York, Academic Press, Inc., 1968.

Experimental methods used in measurements of the elastic and inelastic scattering of electrons by atoms are reviewed. Four sections by different authors cover measurement of electron scattering from a static gas target, measurement of optical excitation functions, crossed-beam electron–neutral experiments, and electron-impact ionization and excitation of positive ions. Emphasis is on principal methods not covered in previous reviews. Numerous references are included. (A.G.W.)

**30338** ATOMIC AND ELECTRON PHYSICS: ATOMIC INTERACTIONS. PART A. Bederson, Benjamin; Fite, Wade L. (eds.). Methods of Experimental Physics. Volume 7. New York, Academic Press, Inc., 1968. 518p. $21.00.

A separate abstract was prepared for each of the four sections of the book. (A.G.W.)

*For abstracts of individual sections see: 30334–30337.*

**30339** MOLECULAR-BEAM MEASUREMENTS OF THE EMISSION SPECTRUM AND RADIATIVE LIFETIME OF $N_2$ IN THE METASTABLE $E^3\Sigma_g^+$ STATE. Freund, Robert S. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 50: 3734-40(May 1, 1969).

Electron-impact excitation of a molecular beam of nitrogen was used to produce the metastable $E^3\Sigma_g^+$ state. This state, which lies 11.87 eV above the ground state, has recently been observed in a number of electron-impact experiments. This paper reports the emission spectrum from the molecular beam, and identifies three forbidden electronic transitions, $E^3\Sigma_g^+ \rightarrow A^3\Sigma_u^+$, $E^3\Sigma_g^+ \rightarrow B^3\Pi_g$, and $E^3\Sigma_g^+ \rightarrow C^3\Pi_u$. Approximate absolute transition probabilities are determined. The radiative lifetime of the E state is 270 ± 100 μsec, and the equilibrium internuclear distance is 1.16 ± 0.02 Å. (auth)

**30340** ABSOLUTE DIFFERENTIAL CROSS SECTIONS OF ELASTICALLY SCATTERED ELECTRONS. I. He, $N_2$, AND CO AT 500 eV. Bromberg, J. Philip (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys., 50: 3906-21(May 1, 1969).

An electron spectrometer especially designed for the study of elastic scattering has been constructed and used to measure absolute differential elastic cross sections of 500-eV electrons scattered from He, CO, and $N_2$. Comparison with calculated values for He indicates that the first Born approximation with exchange gives results that agree with experiment to within 2% at angles greater than 18°. At small angles the observed cross sections exceed the calculated by a large factor. The cross sections for $N_2$ and CO change with angle in very similar ways. (auth)

**30341** A COMPARISON BETWEEN THE PARAMETRIC TREATMENTS OF ION–ATOM COLLISIONS FOR LOW- AND HIGH-IMPACT VELOCITIES. Fennema, J. W. R. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 40: 339-46(1968).

With respect to ion–atom collisions one generally distinguishes between approximative treatments that are valid for low and high impact velocities. When using the parametric picture these respective treatments are connected with the assumptions of "rotating" or "fixed" electron states. It is formally proved that the distinction in question is largely irrelevant if, for any excitation, the couplings between substates differing in magnetic quantum number are accounted for. Theories, for instance the parametric version of a Born approximation, thus corrected should be strongly invalid for intermediate values of the impact velocity only. (auth)

**30342** COLLISION MECHANISM OF A DISSOCIATIVE CHARGE-TRANSFER REACTION AT LOW ENERGY. Masson, A. J.; Birkinshaw, K.; Henchman, M. J. (Brandeis Univ., Waltham, Mass.). J. Chem. Phys., 50: 4112-14(May 1, 1969).

Multiple-pulse techniques were used to investigate the kinematics of the reactions $Ar^+ + CH_4 \rightarrow Ar + CH_3^+ + H$ and $Ar^+ + CH_4 \rightarrow CH_3^+ + H_2$ in the energy range from 1.5 to 4.2 eV. The kinetic energies of the product ions were measured by superimposing a variable

dc repeller voltage upon the repeller pulse program. Two distinct mechanisms are suggested by two distinct plateaus — charge transfer, respectively, with and without momentum transfer. Evidence indicates the transfer of momentum through a bound complex; a model for the mechanism of this momentum-transfer process is proposed. (A.G.W.)

**30343** OPTICAL PUMPING OF NEON $^3P_2$ METASTABLE ATOMS. Schearer, L. D. (Texas Instruments Inc., Dallas). Phys. Rev., 180: 83-90(Apr. 5, 1969).

The $^3P_2$ metastable atoms of neon have been optically oriented. This represents the first case of the optical pumping of non-S-state atoms. The optical-pumping process is described, and depolarization cross sections for collisions with ground-state neon and ground-state helium atoms measured. The cross section for collisional depolarization with helium is $4.30 \pm 0.22 \times 10^{-17}$ cm$^2$, and with neon is $166 \pm 8 \times 10^{-17}$ cm$^2$ at 300°K. The metastable $^3P_2$ atoms of Ar and Xe have also been optically pumped. As the polarizability of the noble-gas buffer increases, the collisional depolarization cross section approaches the diffusion cross section. (auth)

**30344** BREMSSTRAHLUNG CROSS SECTIONS AT MODERATE ENERGIES. Brysk, H.; Zerby, C. D.; Penny, S. K. (Union Carbide Corp., White Plains, N. Y.). Phys. Rev., 180: 104-11 (Apr. 5, 1969).

The bremsstrahlung cross section has been calculated with a relativistic self-consistent-field potential. Results for electrons of 50 to 500 keV incident on gold are presented and compared with experimental data. (auth)

**30345** POPULATION DISTRIBUTIONS. II. CHARGE-EXCHANGE CAPTURE BY PROTONS INCIDENT UPON GROUND-STATE ATOMS. Hiskes, John R. (Univ. of California, Livermore). Phys. Rev., 180: 146-55(Apr. 5, 1969).

The ratios of the excited captures to the total captures have been computed for charge-exchange collision of protons incident upon each of the elements in their ground state. The calculations have been performed for incident proton energies of 5 to 140 keV and employing a simplified form of the Brinkman–Kramers matrix element. Generally speaking the extremes of behavior of the population distributions occur for charge-exchange collisions with the alkalis and with the inert gases; the population distributions for the other target elements fall smoothly within these extremes. The main variations of the population ratios and the primary trends for different target elements agree reasonably well with available experimental data. (auth)

**30346** EXCITATION TRANSFER IN NEARLY ADIABATIC THERMAL COLLISIONS. Gallagher, A. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Phys. Rev., 179: 105-10 (Mar. 5, 1969).

Some sources of error that arise in the use of Stuckelberg's formula for excitation-transfer calculations are pointed out. To demonstrate these difficulties, Stuckelberg's formula for noncrossing levels is used to calculate nearly adiabatic excitation-transfer cross sections for He*, Rb*, and Cs* collisions with inert gases and for alkali*–alkali collisions. In contradiction with another (erroneous) calculation for He*, these cross sections generally disagree with experimental observations by orders of magnitude. The reasons for this and some conditions for the validity of this method of calculating nearly adiabatic cross sections are given. (auth)

**30347** OXYGEN K-SHELL X-RAY PRODUCTION IN THIN FILMS OF ALUMINUM OXIDE BY 20- TO 100-keV PROTONS. Hart, R. R. (Univ. of California, Berkeley); Reuter III, F. William; Smith, Harold P. Jr.; Khan, J. M. Phys. Rev., 179: 4-9(Mar. 5, 1969).

The oxygen K-shell x-ray-production cross section and the stopping power of aluminum oxide for 20- and 100-keV protons were determined by measurements of the oxygen K x-ray yield (x rays/proton) from surface films of aluminum oxide formed on aluminum substrates by anodic oxidation. Ionization-cross-section results are compared with previous measurements of C, Mg, and Al. The comparison shows that the cross sections follow the same trend, but depart from theoretical predictions based on the Born approximation. The stopping power data have maxima at proton energies of 65 and 90 keV, corresponding to peaks in the stopping powers of Al and O. (auth)

**30348** COLLISION-INDUCED DISSOCIATION OF $(HeH)^+$. Schopman, J.; Barua, A. K.; Los, J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Phys. Lett., 29A: 112-13(Apr. 21, 1969).

The velocity distribution of the $H^+$ fragment from the collision-induced dissociation of the $(HeH)^+$ shows that the dissociation does not take place via an electronic excitation; moreover two distinct processes with widely different cross sections are involved. (auth)

**30349** OSCILLATIONS IN THE CROSS SECTIONS OF $Ar^+$–Ar CHARGE TRANSFER. Dewangan, D. P.; Karmohapatro, S. B. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Lett., 29A: 115-16(Apr. 21, 1969).

Oscillations found in $Ar^+$–Ar charge-transfer cross sections calculated by the impact-parameter method in the energy range 0.1 to 160 keV can be explained by the exchange integral involved in the electron-capture probability, which passes through a maximum. (auth)

**30350** NONADIABATIC EFFECTS IN ELECTRON–ATOM INTERACTIONS. Callaway, J. (Louisiana State Univ., Baton Rouge). Phys. Lett., 29A: 126-7(Apr. 21, 1969).

An expression for the distortion potential, which represents the leading nonadiabatic term in the interaction between an electron and an atom, is derived from many-body perturbation theory. (auth)

**30351** INCOHERENT SCATTERING OF 662-keV GAMMA RAYS BY K-SHELL ELECTRONS IN GOLD. Ljubicic, A.; Ilakovac, K.; Knapp, V.; Pisk, K. (Inst. Ruder Boskovic, Zagreb). pp 285-93 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25–28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.
See CONF-670981.

The differential cross section was measured as function of electron energy for the Compton scattering of 662-keV photon by K-shell electrons in gold. (J.W.R.)

**30352** ELEMENTARY PROCESSES OF CHANGE OF CHARGE STATES IN THE INTERACTION BETWEEN PROTONS AND HYDROGEN MOLECULES. Afrosimov, V. V.; Leiko, G. A.; Mamaev, Yu. A.; Panov, M. N. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 56: 1204-16(Apr. 1969). (In Russian).

The cross sections for elementary processes of change of the charge states in $H^+ - H_2$ interactions are measured by simultaneously analyzing of the charge states of fast atomic particles and of particles produced from the target molecules. Particles that are partners of a given encounter are separated by delayed coincidences. By means of simultaneous analysis of the kinetic energies of protons produced in the dissociation of molecular $H_2^+$ ions, the cross sections are determined for elementary processes that possess identical charge-state variation patterns. Cross-section measurements performed for incident proton energies $T_0 = 5$ to 50 keV showed that, for $T_0 \lesssim 30$ keV, electron capture by the impinging proton (charge exchange) is the major process of $H_2^+$ formation. With increase of $T_0$ the role of ionization in which an electron is removed from the $H_2$ molecule becomes greater and for $T_0 \approx 45$ keV the capture and ionization cross sections become equal. The major process of proton formation from $H_2$ molecules is electron capture by the impinging proton with subsequent dissociation of the $H_2^+$ ions from the repulsive $2p\sigma_u$ state and excited electron states. The cross section for capture involving ionization is also quite large. In this process an electron of the $H_2$ molecule is captured by the incident proton and the other is removed into the continuous spectrum. The cross sections for ionization with dissociation and two-electron capture are smaller. An analysis of the dissociation probability in $H_2^+$ ion formation in the $1s\sigma_g$ state shows that electron transitions in the target molecule in $H^+ - H_2$ collisions obey the Franck–Condon principle for all impinging proton energies. (auth)

**30353** ELASTIC SCATTERING PHENOMENA OF METASTABLE HELIUM ATOMS IN THE NATURAL GAS MIXTURE. Fugol, I. Ya. (Physico-Technical Inst. for Low Temperatures, Kharkov). Usp. Fiz. Nauk, 97: 429-52(Mar. 1969). (In Russian).

The elastic scattering of excited He atoms in a gas of normal atoms exhibits a special behavior due to quantum symmetry effects and to some specific interactions. In order to examine this behavior, the total and diffusion cross sections and the processes of scattering of metastable atoms were investigated, as they take place according to the equation $He^*(2^3S) + He(1^1S) \rightarrow He(1^1S) + He^*(2^3S)$ with excitation transfer. In this process, the energy is transferred from one identical nucleus to another without any exchange of energy with respect to the internal motion of the individual atoms. The elastic scattering of metastable atoms involves symmetric and antisymmetric potentials, $V_S$ and $V_A$, which belong to two separate states of normal and metastable atoms; they differ by the symmetry of the wave function. Results of theoretical and experimental studies on cross sections of elastic phenomena are reviewed; the interaction potential is specifically examined. The method developed may be applied to similar systems with remote repulsion. (41 references) (TTT)

## Atomic Theory

**30354** PERTURBED HARTREE–FOCK THEORY. I. DIAGRAMMATIC DOUBLE-PERTURBATION ANALYSIS. Caves, T. C.; Karplus, M. (Harvard Univ., Cambridge, Mass. Columbia Univ., New York). J. Chem. Phys., 50: 3649-61(May 1, 1969).

The coupled Hartree–Fock scheme, for calculating atomic and molecular properties that are second order in some perturbing field, is studied with the help of a double-perturbation expansion and diagrammatic techniques. The double-perturbation expansion, with the external field as one perturbation ($\mathcal{H}^{(1)}$) and the difference between the true electron-repulsion potential and the Hartree–Fock potential as the other (V), is compared with an iterative solution of the set of coupled Hartree–Fock equations for the first-order perturbed orbitals. The term in the double-perturbation expansion that is second order in $\mathcal{H}^{(1)}$ and zeroth order in V is shown to be the Dalgarno "uncoupled" second-order energy. The coupled Hartree–Fock second-order (in $\mathcal{H}^{(1)}$) energy expression includes all terms first order in V and some of the terms to all orders in V, up to infinite order. It is shown how to separate the diagrams contributing to the CPHF energy from those that do not; in particular, the CPHF equations are composed of the so-called "bubble diagrams" and their corresponding exchange diagrams. It is shown that each particle–hole pair, or "bubble," is independent of all the other particle–hole pairs, in the sense that the total energy contribution from the diagram can be factored into contributions from the individual particle–hole pairs. It is shown that the first-order perturbed wave function obtained from the coupled Hartree–Fock formalism includes effects due to all singly excited determinants and a certain class of linear combinations of doubly excited determinants, namely those singlet spin eigenfunctions that correspond to two electrons being excited without spin flips from Hartree–Fock unexcited orbitals to virtual orbitals; there exists a second, linearly independent, doubly excited singlet function that is not included in the CPHF wave function and does not contribute to the perturbation energy. The contribution to the second-order energy from the doubly excited determinants amounts to about 10% of the total CPHF second-order energy in the case of some electric and magnetic properties of $H_2$ and 25% of the total second-order energy corresponding to the electric dipole polarizability of the Be atom. The larger contribution of the terms involving doubly excited determinants for Be has its origin in the fact that a double excitation from the 2s to the 2p orbital gives a large fraction of the correlation energy between the 2s electrons and that the single excitation from the 2s to the 2p orbital is the largest single contribution to the polarizability. An alternate iterative scheme for the solution of the coupled Hartree–Fock equations is derived. This alternate iterative scheme, which includes certain terms summed to infinite order, is expected to be a considerable improvement over the simple scheme, which starts with the "uncoupled" approximation as the zeroth iteration. Comparisons of the different schemes for the properties considered in this paper are made to confirm this conclusion. The CPHF energy (second order in $\mathcal{H}^{(1)}$) is partitioned approximately into a part due to correcting the unperturbed Hartree–Fock wave function for correlation and a part due to correcting the uncoupled Hartree–Fock perturbed wave function for correlation; the contribution from the former was shown to be about 10% to 20% of that from the latter. (auth)

**30355** MULTIPLE SOLUTIONS TO THE HARTREE–FOCK PROBLEM. II. MOLECULAR WAVE FUNCTIONS IN THE LIMIT OF INFINITE INTERNUCLEAR SEPARATION. King, Harry F. (State Univ. of New York, Buffalo); Stanton, Richard E. J. Chem. Phys., 50: 3789-97(May 1, 1969).

The restricted Hartree–Fock equation for a closed-shell molecule is investigated in the limit of infinite internuclear separation. The conventional molecular equation reduces, in the limit, to a set of modified Hartree–Fock equations for the individual fragments. The modification consists of admitting fractional occupation numbers for occupied orbitals. The individual fragment equations are coupled by conditions on the orbital energies and on the fractional "charges." The self-consistent field equation, being nonlinear, admits a variety of mathematically acceptable solutions. For lithium hydride a wave function corresponding to ionic fragments $Li^+$ and $H^-$ is one such limiting solution. Contrary to popular notion, it is not the solution of lowest energy even within the restricted SCF formalism. Limiting solutions are obtained for $H_2$, LiH, and $CH_4$. The separated hydrogen molecule is shown to have an SCF energy exactly one-quarter that of the helium atom. The long-range interaction of two hydrogen atoms is described by an inverse first-power potential according to Hartree–Fock theory. The Z dependence of correlation energy at infinite separation is analyzed in terms of a charge-transfer process. It is argued that in passing from the equilibrium separation to infinity the ground-state SCF wave function for a molecule such as lithium hydride becomes at first more and then less ionic. (auth)

**30356** RESONANCE RADIATION FROM INTERACTING ATOMS. Czarnik, John W.; Fontana, Peter R. (Oregon State Univ., Corvallis). J. Chem. Phys., 50: 4071-4(May 1, 1969).

The frequency distribution of resonant radiation emitted by a system of two identical interacting atoms is calculated. The separation between the atoms is assumed to be much larger than the size of their charge distributions. Initially one atom is excited while the second one is in the ground state. The two atoms are coupled through the radiation field and the electrostatic interaction. For not too large internuclear separations the line shape of the emitted radiation exhibits two distinct peaks, and the general features are identical with the result obtained from resonance fluorescence scattering. In the decay process, however, there is equal probability of scattering through the symmetric and antisymmetric states, and thus the peak heights of the emitted radiation are different from the ones in the resonance fluorescent case. For large internuclear separations the two peaks merge into the one characteristic of the line shape of a single isolated atom. (auth)

**30357** ATOMS. Hughes, Vernon W. (Yale Univ., New Haven). Phys. Today, 22: No. 2, 33-7(Feb. 1969).

Frontiers of modern atomic physics are reviewed. Calculational techniques in and experimental tests of quantum electrodynamics are discussed. Unsolved questions, such as the divergences in QED theory, the calculation of the value of the fine-structure constant, and the relation of the muon and the electron, are pointed out. The role of invariance and symmetry principles in atomic physics is considered; space reflection, time reversal, and charge-conjugation invariances can be tested for the electromagnetic interaction. Other parts of the frontier involve atomic structure, atomic collisions, muonic and mesic atoms, masers and lasers, and applications in astrophysics. (A.G.W.)

**30358** SIMPLIFICATION OF THE PERTURBATION THEORY OF ATOMS AND MOLECULES BY USE OF SEPARABLE POTENTIALS. Hausmann, K. (Technische Univ., Dresden). Ann. Phys. (Leipzig), 21: 106-12(1968). (In German).

A simple model Hamilton operator was constructed from the Hartree–Fock one-electron wave functions existing in the ground state. This one-electron operator contains in addition to the kinetic energy a superposition of projection operators. It includes only the occupied Hartree–Fock state as the bound state. The calculation of the unoccupied state and therefore the perturbation term is much simpler than in the Hartree–Fock operator. For the helium atom the perturbation series pertinent to the model operator converges almost as rapidly as the perturbation theory coming from the Hartree–Fock operator. (tr-auth)

**30359** PERTURBATION TREATMENT OF THE HARTREE–FOCK EQUATIONS FOR THE GROUND STATES OF THE BORON-LIKE IONS. Sharma, C. S.; Wilson, R. G. (London Univ.). Can. J. Phys., 47: 699-705(Apr. 1, 1969).

The first-order Hartree–Fock and unrestricted Hartree–Fock equations for the ground state of a five-electron atomic system are solved exactly. The solutions are used to evaluate the corresponding second-order energies exactly and the third-order energies with great accuracy. The first-order terms in the expectation values of $1/r$, $r$, $r^2$, and $\delta(r)$ are also calculated. (auth)

**30360** SCHROEDINGER EQUATION RESOLUTION FOR ARBITRARY ATOMS. Dombrovski, L. Compt. Rend. Acad. Bulg. Sci., 22: 5-6(1969). (In Russian).

A generalized Schroedinger equation was developed for any arbitrary electron quantity. The equation involves a new conversion of independent variables, which results in an effective convergence and produces a simple expression for the wave function. (R.V.J.)

**30361** NUMERICAL SOLUTION OF THE 2- AND 3-DIMENSIONAL SCHROEDINGER EQUATION FOR ANY MOLECULAR POTENTIALS. IV. TRANSFORMATION OF THE POTENTIAL IN A GENERAL FINITE AND CONTINUOUS PSEUDOPOTENTIAL. COMPUTER PROGRAM IN DISTORTED SPHERICAL OR ELLIPTICAL COORDINATES WITH FINITE DEFINITION REGION. Seelig, Friedrich Franz (Univ., Marburg, Ger.). Z. Naturforsch., 23a: 1301-7(Sept. 1968). (In German).

The method for the numerical solution of the 2- and 3-dimensional Schroedinger equation by iterative variation of numerical trial functions by a digital computer as given in previous sections of this series of papers is improved by two alterations: (1) The wave function is again formulated as a product of a state-specific part that is submitted to variations and a constant part (with respect to the states). The latter is now given in such a way

that the cusps at the nuclei are rendered in the correct way. (2) The problem is treated in polar and spheroidal coordinates distorted in such a way that the infinite domains of ordinary space are transformed into finite domains of these distorted coordinates. Two programs in FORTRAN IV are sketched, one 2-dimensional for molecules with cylindrical symmetry and the other 3-dimensional for the normal case. Both programs are suited for both types of coordinates. Some states of $H_2^+$ and $HeH^{2+}$ are treated as tests. Error in energy is about 0.13 per cent for $H_2^+$ and about 0.11 per cent for $HeH^{2+}$ in a relatively coarse mesh (20 × 10 and 25 × 20 resp.). (auth)

## Cosmic Radiation

*Refer also to abstracts 30214, 30285, 30690, 30691, 30708, and 30766.*

**30362** (N-69-20028) GAMMA-RAY ASTRONOMY BALLOON RESULTS. Fichtel, C. E.; Kniffen, D. A.; Ogelman, H. B. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Feb. 1969. 41p. (NASA-TM-X-63482; X-611-69-58). CFSTI.

Results are given for high-altitude balloon flights of the Goddard gamma-ray digitized spark chamber telescope. The data on the galactic center region is reanalyzed in terms of a possible line source in the galactic plane. The flux and energy spectrum of the atmospheric background were measured as a function of angle with respect to the vertical. The measured downward flux is in reasonable agreement with measurements of other experimenters at several energies; however, the upward flux for energies above 100 MeV is a factor of about three lower than that measured in the OSO-3 experiment. This difference seems larger than would be expected, but small compared to the difference between the galactic gamma-ray flux observed by OSO-3 and the predicted one. The upper limits to possible point sources of gamma rays are summarized and shown generally to fall below the fluxes expected from a straight extrapolation of the x-ray spectra. No positive evidence for a point source has been found. (auth) (STAR)

**30363** (UCRL-50502) THE VERTICAL AND OMNIDIRECTIONAL COSMIC RAY INTENSITIES AS A FUNCTION OF LATITUDE AND LONGITUDE FOR VARIOUS POINTS NEAR THE GEOGRAPHIC EQUATOR. D'Arcy, R. G.; MacGregor, G. A. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 13, 1968. 70p. Dep. CFSTI.

Tables show the corrected cosmic ray intensities correlated with latitude and longitude as seen by a large area scintillator-type cosmic ray telescope and omnidirectional detector. The experiment was flown at altitude depths of 200 to 250 g/cm² between Hawaii and New Zealand, Hawaii and Alaska, and completely around the world near the geographic equator in March and April of 1967. Statistical errors in the minute count rates were less than 1% and overall experimental errors totaled less than 2%. (auth)

**30364** COSMIC RAYS. Rosen, Stephen. Sci. Technol. (N.Y.), No. 83, 22-30(Nov. 1968).

Various known facts and unanswered questions concerning cosmic radiation are reviewed. A thermonuclear model for cosmic ray generation is discussed. The model incorporates current ideas on stellar collapse and element-building in stars (nucleosynthesis) with a mechanism by which the stellar nuclei are accelerated by the shock waves that accompany an expanding supernova shell. Though acceleration mechanisms are still quite speculative, there is some observational evidence for the thermonuclear origin of cosmic rays. The cosmic-ray energy spectrum appears to change its shape at about $10^{15}$ eV, and perhaps again at $10^{17}$ eV. This could be indicative of one source (or set of sources) becoming weaker, and another getting stronger. For example, supernovae may not be able to generate particles which exceed $10^{15}$ eV, but perhaps explosions of the core in this and other galaxies produce cosmic rays in the range of $10^{15}$ to $10^{17}$ eV, and perhaps quasi-stellar objects form the rare super-high-energy protons up to $10^{20}$ eV. The interactions of heavy cosmic-ray nuclei with interstellar targets are considered. The enrichment of cosmic-ray Li, Be, and B can be accounted for by the spallation of heavy nuclei during their passage through ~5 g/cm² of interstellar gas. The movement of the charged cosmic rays through the magnetic gas clouds is explained. Evidence of decreased isotropy and energy spectrum change, both at elevated energies, support the hypothesis of extragalactic origin of cosmic rays. (BBB)

**30365** RADIO PULSE PRODUCTION IN EXTENSIVE AIR SHOWERS. Allan, H. R. (Imperial Coll. of Science and Tech., London); Clay, R. W.; Jones, J. K.; Abrosimov, A. T.; Neat, K. P. Nature (London), 222: 635-7(May 17, 1969).

Measurements of radio pulse production at the Haverah Park air shower array indicated that the geomagnetic mechanism is dominant at both 32 and 44 MHz. (auth) (UK)

**30366** INVESTIGATION OF ANGULAR AND ENERGY DISTRIBUTIONS OF SHOWER PARTICLES AT THE ENERGY REGION 100 TO 400 GeV. Takibaev, Zh. S.; Eremenko, Yu. A. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 9: 809-17(Apr. 1969). (In Russian).

60 showers with $E_0 > 100$ GeV registered by a set-up consisting of a Wilson chamber and an ionization calorimeter were investigated. The target was 7 g · cm$^{-2}$ thick carbon. It is shown that the parameters $\sigma$ and D may be considered as random and noncorrelated quantities. The number of "two-bump" showers is inside the range of fluctuations. The angular distribution in the S frame for cases of one-fireball production is not an isotropic one. All these facts are in contradiction with the fireball model. Most of the asymmetrical showers are explained by fluctuations in the angular distributions, by the measurement errors and by the non-nucleon-nucleon interactions. However, the data do not contradict the existence of asymmetrical showers [(14 ± 10)%] that can not be explained in such a way. In the analysis the showers observed at the Cosmic Ray Laboratory of the Physical Institute were used. (auth)

**30367** COSMIC RAYS IN THE EXPANDING UNIVERSE. Rozental, I. L.; Shukalov, I. B. Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 1793-5(Nov. 1968). (In Russian).

Data on quasars and explosive processes were analyzed and an attempt was made toward quantitative analysis of these phenomena as possible sources of cosmic rays. Results showed that, assuming that the density of the cosmic rays in the metagalaxy are of the upper boundary (in certain maximum cases, the "open" Galaxy and cosmic rays fill out uniformly the whole volume and part of the halo volume) then $W_{mg} \approx W_g$. In maximum cases separation of cosmic rays into galactic and metagalactic is a conditional concept. Assuming uniform density of cosmic rays in the Galaxy one obtains $W_{mg} \approx W_g$ (with the reverse $W_g \approx W_{mg}$ being trivial). (R.V.J.)

**30368** INTERACTION OF COSMIC PROTONS WITH THE INTERPLANETARY PLASMA. Nikolaev, Yu. M. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., 24: 113-16(Jan.-Feb., 1969). (In Russian).

The interaction of protons from galactic and solar cosmic rays with the nonisothermal plasma of the solar wind causes complex effects such as beam instability, plasma turbulence, proton energy losses upon excitation of the plasma wave spectrum, etc. Energy losses of a nonrelativistic proton beam upon excitation of longitudinal electrostatic oscillations of the interplanetary plasma were examined, considering a homogeneous, nonisothermal, infinite, completely ionized plasma. The resulting excitation of longitudinal electrostatic oscillations was studied, pointing out that low-frequency magnetohydrodynamic oscillations may be generated in the interplanetary plasma. Consideration of the low-frequency branch of the spectrum may change earlier concepts. (TTT)

**30369** MEAN FREE PATHS OF COSMIC RAYS THROUGH A FAR-INFRARED RADIATION FIELD. Encrenaz, P.; Partridge, R. B. (Princeton Univ., N. J.). Astrophys. Lett., 3: 161-4(May 1969).

The propagation of high-energy cosmic protons, electrons, and photons through a universally distributed cosmic microwave background is considered. It is shown that high-energy cosmic rays must originate locally. Available observations are in better agreement with a blackbody microwave spectrum than with the higher temperature grey-body spectrum suggested by Shivanandan et al. (1968). (auth)

**30370** ORIGIN OF GALACTIC GAMMA-RAYS. Stecker, F. W. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London), 222: 865(May 31, 1969).

A brief review is given of observational "gamma-ray astronomy," since the detection of cosmic gamma rays with energies above 100 MeV in 1968. Taking all the evidence concerning the origin of this radiation into account it seems likely that it emanates from collision processes in interstellar gas in the galactic disk, with a mean density of 5 cm$^{-3}$. Production of neutral pi-mesons and bremsstrahlung in interstellar cosmic-ray collisions would account for the observed gamma rays. (UK)

**30371** ON THE PARALLEL PENETRATING PARTICLES UNDERGROUND AS E.A.S. MUONIC COMPONENT. Castagnoli, C. (Univ., Turin); Picchi, P.; Verri, G. Nuovo Cim., 61B: 290-302(June 11, 1969).

A calculation on the nuclear cascade in high energy E.A.S. is performed by using a composite isobaric model, in order to study the muon density function $\Delta(N, R, > E_\mu)$, where R is the distance

from the axis of the E.A.S., $E_\mu$ the muon energy and N the size of the E.A.S. The obtained expression shows a good agreement with experimental data on the muonic component of the E.A.S. The $\Delta(N, R, > E_\mu)$ is then used to interpret the results obtained up to now on the parallel penetrating particles underground as resulting from the very penetrating muonic component of the E.A.S. At depths greater than 200 m w.e. a disagreement is found between the calculations and the experimental data. Some discussion is given of the basis for this discrepancy. (auth)

**30372** MONTE CARLO STUDIES ON THE HADRONIC COMPONENT OF EXTENSIVE AIR SHOWERS. Thielheim, K. O.; Beiersdorf, R. (Univ., Kiel). J. Phys., A (London), 2: 341-53 (May 1969).

Three-dimensional Monte Carlo calculations were performed on the development of the hadronic component of extensive air showers using a semi-empirical model of high-energy nuclear interactions. Results include integral energy spectra and lateral distribution of nuclear active particles as well as total hadronic energy flux. The probability of multi-core showers is discussed. The contribution of pionization tends to mask the dependence of this probability on primary atomic number. Fluctuations of total and central hadronic energy flux were investigated. Maps of hadronic energy flux in the core region of individual showers are presented. (auth)

**30373** OBSERVATIONS OF MULTIPLE MUONS IN COSMIC RAYS AT A VARIETY OF ZENITH ANGLES. Rogers, I. W.; Thompson, M. G.; Turner, M. J. L.; Wolfendale, A. W. (Univ. of Durham, Eng.). J. Phys., A (London), 2: 365-73(May 1969).

A large vertical array of muon detectors was used to measure the frequency of multiple muons from extensive air showers as a function of zenith angle over the range 30 to 85°. The experimental data are compared with the predictions of the theory developed previously; accepting the values of the parameters used in this theory, it is concluded that there is no evidence for a large increase in the relative flux of heavy nuclei in the energy range $10^{15}$ to $10^{17}$ eV. If all the other parameters except the mean transverse momentum $\langle p_T \rangle$ are assumed to be known, the data suggest a mean value of $\langle p_T \rangle$ increasing from 0.37 to 0.44 GeV/c as the interaction energy increases from 200 to 3000 GeV. (auth)

**30374** A THEORETICAL ANALYSIS OF EXTENSIVE AIR SHOWERS. III. MUON SHOWERS AT LARGE ZENITH ANGLES. de Beer, J. F.; Holyoak, B.; Turner, M. J. L.; Wdowczyk, J.; Wolfendale, A. W. (Univ. of Durham, Eng.). J. Phys., A (London), 2: 354-64(May 1969).

A theoretical analysis was made of the muon component of extensive air showers incident at large angles to the vertical. Using the model described previously, calculations were made of the expected numbers of muons reaching ground level as a function of threshold energy and zenith angle for primary particles of various energies. The data were combined with alternative primary spectra of cosmic rays, with and without an enhanced contribution from heavy nuclei, to give the expected muon density spectra. It is found that the density spectrum is sensitive to the distribution of transverse momentum among the parents of the muons and to a lesser extent to the mass composition of the primaries. There is thus the possibility of deriving information about the mean transverse momentum, and perhaps setting limits on the mass composition, from a comparison with experiment. (auth)

**30375** MUON SHOWERS DEEP UNDERGROUND. Porter, L. G.; Stenerson, R. O. (Univ. of Utah, Salt Lake City). J. Phys., A (London), 2: 374-91(May 1969).

Data gathered with the University of Utah neutrino detector during late spring and summer of 1967 were used to study penetrating muon showers. These downward-going events contained two or more nearly parallel muons incident in a range of zenith angles between 30 and 75°, having penetrated from 1500 to 6000 hg $cm^{-2}$ of rock overburden. Studies were made to determine the radial extent of the showers and the frequency of occurrences of showers of each multiplicity, and the degree of isotropy of the arrival directions of shower events was plotted in celestial coordinates, with the result that these shower events could be characterized by a radius of 6 to 10 m, a multiplicity spectrum which is a power law in multiplicity having an exponent between −3.4 and −4.0, and no observable anisotropy. These shower data, together with measurements of events containing a single penetrating muon, were used to derive an empirical shower density function that accounts for the energy and angular dependence of the events of multiplicity 1, 2 and 3, as well as the absolute numbers of these events observed. (auth)

## Direct Energy Conversion

*Refer also to abstract 30142.*

**30376** (AD-682722) THERMOELECTRIC GENERATORS PP-6074 ( )/U AND PP-6075 ( )/U. Guazzoni, Guido E.; Nichols, Richard T. (Army Electronics Command, Fort Monmouth, N. J.). Dec. 1968. 36p. (ECOM-3069). CFSTI.

Engineering development studies are described on 10- and 20-A 28-V dc power sources of the thermoelectric type to ascertain the validity of the mechanical design and to determine physical and electrical performance characteristics. The results of tests on a total of six units are related herein to the behavior of major subassembly components. (auth) (USGRDR)

**30377** (AD-683097) ELEMENTS OF THE GENERAL THEORY OF TRANSIENT WORK PROCESSES OF LIQUID-METAL MHD CONDUCTION TYPE GENERATORS. Patrashev, A. N.; Ryabinin, A. G.; Khozhainov, A. I. Translation of a Monograph. 31p. (FTD-HT-23-586-68). CFSTI.

The theoretical research is applicable to a laminar flow regime of the liquid metal in the channel of an MHD generator. These flow conditions can be the working conditions. In addition, at high speeds of the liquid metal the flow conditions can be turbulent. An analysis of the attained solutions has made it possible to establish that during laminar flow conditions of a liquid metal, for a description of the change with respect to time of the integral parameters of the flow, one can successfully make use of a quasi-stationary approximation taking into account frictional forces. This opens broad horizons in the study of transient working conditions of MHD generators during turbulent flow of the liquid metal. In this case it is necessary to deal exclusively with nonlinear equations. Studies showed that a turbulent flow regime of a liquid metal does not influence the character of transient processes in the channel of an MHD generator very significantly. This is explained by the decisive influence of electromagnetic and inertial forces in comparison with forces of friction. (auth) (USGRDR)

**30378** (AD-683131) THE ENIN-2-EXPERIMENTAL OPEN CYCLE MHD GENERATOR RIG. Zhimerin, D. G.; Bashilov, V. A.; Motulevich, V. P. Translation of a Monograph. 13p. (FTD-MT-24-175-68). CFSTI.

An experimental rig was set up to study the processes taking place in the duct of an open-cycle MHD generator. The installation consists of a combustion chamber unit in which natural gas is oxidized in an air atmosphere enriched in oxygen (up to pure $O_2$) with ionizing seeds of different types. The pressure in the duct can go up to 50 atm and the temperature to 3500°K. As the combustion products pass into the duct, the nozzle system can vary the Mach number from subsonic to Mach 3. The duct has a rectangular section. Its maximum dimensions, determined by the magnet bore, are $0.2 \times 0.34 \times 2.5$ m. The ducts are interchangeable to give the possibility of varying the area modification law relating to the section along the axis of the duct and of altering the electrode circuit or the size of the electrodes or insulation gaps, etc. The combustion chamber, nozzle and duct are made of stainless steel and are water-cooled; a coating of aluminum oxide serves as insulation. Depending on the mode of operation, the installation's calculated power and electric power are in the neighborhood of 250 MW and 10 MW, respectively. (USGRDR)

**30379** (AD-683793) ELECTRODE TEMPERATURE EFFECT ON MHD GENERATOR PERFORMANCE. Eustis, R. H.; Mitchner, M.; Kruger, C. H. (Stanford Univ., Calif. Plasma Gasdynamics Lab.). Jan. 1969. Contract F33615-67-C-1127. 63p. CFSTI.

Five segmented electrode pairs capable of controlled temperatures between 700 and 1700°K were mounted at the downstream end of the MHD channel. The temperature of the electrode wall upstream of the electrode was controlled at two values, 750 and 2400°K. By means of probes mounted in the sidewall, it was possible to measure the voltage drop at the electrodes due to the combined boundary layer and surface-sheath effects. Results showed that hot electrodes performed considerably better than cold electrodes and that anode voltage losses were largely due to boundary-layer losses while cathode losses were caused by boundary-layer and surface-sheath effects. Computer calculations were made to show the effect of electrode size for three types of gas conductivity profiles corresponding to no thermal boundary-layer and cold and hot boundary-layers. Spectroscopic measurements of the boundary-layer temperature showed that the profile could be represented by a power-law enthalpy profile with the exponent equal to $\frac{1}{9}$. An experiment was made to determine if finite recombination rates had a significant effect in combustion MHD generators. Techniques were investigated for measuring electron temperature and number density in combustion gas plasmas. (auth) (USGRDR)

**30380** (AEC-tr-7044) INSTITUTE FOR ENERGY CONVERSION AND ELECTRIC THRUSTORS. Translated from a Reprint of the Jahresbericht 1967 (Annual Report 1967) of the Deutsche

Versuchsanstalt fuer Luft- und Raumfahrt E. V., Stuttgart, Germany. 39p. Dep. CFSTI.

Research was conducted on magnetofluiddynamic and thermionic energy conversion and low-power electric thrustors (plasma accelerators) for space vehicles. In the field of MFD, work was done on inductive liquid-metal and plasma generators. For thermionic converters, the compatibility of materials with Ba vapor was tested, and cermet electrodes and boundary layers were investigated. Thrustors studied included inductive plasma accelerators with standing waves, Hall accelerators, and continuous traveling-wave accelerators. (D.L.C.)

**30381** (N-69-20852) COMPARISON OF BRAYTON AND RANKINE CYCLE MAGNETOGASDYNAMIC SPACE-POWER GENERATION SYSTEMS. Nichols, Lester D. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1969. 59p. (NASA-TN-D-5085). CFSTI.

Idealized Brayton-and Rankine-MHD cycles are considered for use in space. The Brayton-MHD cycle uses neon as the working fluid; the Rankine-MHD uses lithium. Both are seeded with cesium. The systems are restricted to a specified generator length and specific radiator area. It is shown that generally an entrance Mach number of 1.0 provides maximum power output; for the same value of Hall parameter the Rankine-MHD system may be used at a lower temperature than the Brayton-MHD; but at the same maximum temperature the Brayton-MHD generates more power than the Rankine-MHD. Subsonic entrance Mach number is recommended for Brayton-MHD, and supersonic for Rankine-MHD. (auth) (STAR)

**30382** (N-69-20875) ELECTROTHERMAL INSTABILITIES IN THE ENTRANCE REGION OF AN MHD GENERATOR. Smith, J. Marlin (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1969. 23p. (NASA-TM-X-1761). CFSTI.

In the entrance region of a nonequilibrium MHD generator one finds an abrupt rise in electron temperature followed by a four- or five-decade increase in electron density. The stability of this region of abrupt electron density rise is considered. A solution is found in the limit that the ambipolar diffusion field is small compared to the transverse applied electric field. The solution is found to be stable in the limit of zero magnetic field but to be unstable in the presence of a magnetic field. (auth) (STAR)

**30383** (N-69-21376) ANALYSIS OF A MULTISTAGE LIQUID METAL MAGNETOHYDRODYNAMIC POWER CONVERSION CYCLE. Hays, L. G. (Jet Propulsion Lab., Pasadena, Calif.). Apr. 1, 1969. Contract NAS7-100. 12p. (NASA-CR-100500; JPL-TR-32-1371). CFSTI.

A liquid metal magnetohydrodynamic (MHD) power system with power extraction at several stages in the expansion process is discussed and analyzed. Cycle efficiency is shown to improve from the 6% range for a single stage 1800°F system to the 10% range for multistage 1800°F systems. Cycle efficiency at 2000°F is slightly lower but a smaller radiator area is attainable than at 1800°F. The advantages of lower liquid metal velocities and MHD generator redundancy are also possible in a multistage system. (auth) (STAR)

**30384** (NP-17875) MHD ELECTRICAL POWER GENERATION. The 1969 Status Report. (European Nuclear Energy Agency, Paris (France)). Apr. 1969. 68p. Dep.

The current status of MHD Electrical Power Generation is reviewed with its application to large-scale, commercial power generation receiving primary consideration. The report is based on the information presented at the Fourth International Symposium on MHD Electrical Power Generation held in Warsaw during July 1968, but takes note of important subsequent developments. (auth)

**30385** EXPERIMENTAL STUDY OF MHD GENERATOR DUCTS FOR LONG OPERATION. Morikawa, Tetsuya; Murai, Yutaka (Mitsubishi Electric Corp., Amagasaki, Japan). Mitsubishi Denki Giho, 43: 579-85(Apr. 1969). (In Japanese).

In open-cycle MHD generators, working gases passing through generator ducts and containing highly corrosive elements such as seed materials and ash are maintained at high temperature and high velocity. To protect the structure from them, water-cooled wall ducts constructed of metallic elements and semi-hot wall ducts built of ceramic materials with the surface temperature controlled to remain within their permissible limits are considered for use in the MHD generator ducts of long operation. However, good progress has not been made with the latter construction. A new type of semi-hot-wall duct, based on a unique idea, and proving to be superior to the water-cooled ducts in thermal and electric characteristics, is described here. (NSA of Japan)

**30386** IMPROVEMENTS IN OR RELATING TO METHODS OF MAGNETO-HYDRODYNAMIC PRODUCTION OF ELECTRICITY. Poncelet, Jacques (to Institut Francais du Petrole des Carburants et Lubrifiants). British Patent 1,154,719. June 11, 1969. Priority date Sept. 9, 1965, France.

A method is described for obtaining a gaseous fluid of high electrical conductivity, for magnetohydrodynamic production of electricity. This method involves introducing into a combustion zone constituents comprising a hydrocarbon, an oxidizing gas, and a monatomic element having an ionization potential lower than 8 eV. The combustion is carried out in the presence of at least one substance capable of forming CN chemical radicals in the combustion gases. (M.H.R.)

## Fluid Physics

**30387** (AD-679661) COMPUTATION OF THE BOUNDARY-LAYER FLOW ON THE ELECTRICALLY CONDUCTIVE WALL OF A FLAT CHANNEL. Paskonov, V. M.; Yakubenko, A. E. Translated by H. Peck from Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 3, 12-19(1966). 18p. (FTD-HT-23-1296-67). CFSTI.

Magnetohydrodynamic boundary-layer-flow equations, based on the numerical calculation methods used for the boundary layer of a nonconducting fluid, are analyzed by separating the problems of a flow inside the flow center and of a flow within the boundary layer. The problem of finding the characteristics inside a flowing gas center is reduced to the solution of a differential equation with the boundary conditions for subsonic- and supersonic-flow speeds. For both, the numerical evaluations of flow characteristics were used for solving the equations of the boundary layer. (auth) (USGRDR)

**30388** (AD-680006) COMPUTER PROGRAM FOR THE CALCULATION OF ELECTRIC FIELDS IN AN ELECTROFLUIDDYNAMIC GENERATOR. Final Report, July 1, 1965-June 30, 1968. Minardi, John E. (Dayton Univ., Ohio. Research Inst.). Aug. 1968. Contract AF33(615)-3203. 164p. (UDRI-TR-68-37; ARL-68-0156). CFSTI.

A computer program for the determination of the electric field within an electrofluiddynamic generator is presented. The program produces constant potential lines, constant radial (or transverse) field intensity lines, constant axial field intensity lines and lines of constant magnitude of electric field intensity. The program is suitable for two-dimensional or axisymmetric geometries. A listing of the program is presented with a discussion of the input and output that will enable an independent investigator to use the program. Also presented is an example problem including the input and output. (auth) (USGRDR)

**30389** (AD-681513) RESISTIVE INSTABILITIES OF A VISCOUS MAGNETOFLUID. Report No. Scientific-60. Unteregger, Peter (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). Nov. 25, 1968. Contract F61052-67-C-0014. 19p. (AFOSR-69-121-TR). CFSTI.

The simultaneous influence of finite electrical conductivity and viscosity in the presence of a possibly varying gravitational field on the oscillatory modes of a plasma is examined, using the linearized nonideal magnetohydrodynamic equations. It is shown that hydromagnetic modes of an inhomogeneous, incompressible plasma are strongly influenced by the behavior of the "Alfven frequency." Furthermore, when the magnetic field of the equilibrium configuration is perpendicular to the wave vector of the perturbation, the magnetic field has no influence on all possible oscillatory-mode eigenfunctions. Finally, new modes due to the simultaneous introduction of finite electric conductivity and viscosity are found. In the limit of zero viscosity or infinite electric conductivity the results correspond to those previously obtained. (auth) (USGRDR)

**30390** (AD-681711) LINEAR HYDRODYNAMIC AND HYDROMAGNETIC STABILITY OF THE DISSIPATIVE, TWO-FLUID CYLINDRICAL COUETTE PROBLEM. Schneyer, Gary P. (California Univ., Berkeley. Div. of Aeronautical Sciences). Nov. 1968. Contract Nonr-222(45). 142p. (AS-68-12). CFSTI.

Thesis.

The linear hydrodynamic and hydromagnetic stability of two incompressible, immiscible, dissipative fluids occupying separate annular regions of a cylindrical Couette apparatus is considered. The equations and boundary conditions governing this problem with arbitrary jumps in fluid properties and an applied axial magnetic field but without surface tension were derived; and computer programs written to solve them. Results are presented on the effect of density and viscosity jumps, varying gap widths and differing fluid-fluid interfacial positions on the hydrodynamic stability of this problem. Evaluation of the linear hydromagnetic stability problem was postponed, as was the consideration of un-

stably stratified fluids. Two separate modes (multiple eigenvalues) were discovered for all cases in which two fluids, differing in any property, are present. A rationale is presented for this phenomenon as well as for most of the other observed results. While most of the observed results are attributed to manifestations of the Taylor cylindrical Couette instability phenomenon, evidence is presented for the existence of additional "hidden" eigenvalues attributable to the classical Kelvin/Hemholtz and/or Yih viscosity jump instabilities. (auth) (USGRDR)

**30391** (AD-685248) ELECTROFLUID DYNAMICS. Annual Summary Report. Napolitano, L. G. (Naples Univ. (Italy). Istituto di Aerodinamica). Jan. 1969. Contract AF61(052)-913. 134p. (IA-140; ARL-69-27). CFSTI.

The report consists of two parts. In Part I, a general phenomenological theory for the motion of polarizable fluids is presented. In Part II, the problem of electrofluiddynamic constant-area channel flow is formulated and solved. (auth) (USGRDR)

**30392** (CONF-660326) SEVENTH SYMPOSIUM ON ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS, PRINCETON, N. J., MARCH 30-APRIL 1, 1966. (Princeton Univ., N. J.). 140p.

Two types of presentations are included in this symposium preprint. The twenty-minute papers generally describe completed work and their full texts are preprinted. The ten-minute presentations deal primarily with work in progress, and are represented by their abstracts. A total of 37 papers or abstracts are presented. (M.H.R.)

**30393** CANONICAL TRANSFORMATION OF MAGNETOHYDRODYNAMIC EQUATIONS. Wartique, J. M. (Institut de Mathematique, Liege). Bull. Soc. Roy. Sci. Liege, 37: 428-32 (1968). (In French).

The Clebsch transformation is generalized to the magnetohydrodynamic case, and the equation of motion is applied to a nonviscous perfectly conducting incompressible fluid. Thus a form similar to the Hamilton canonical equations is found, provided a generalized hamiltonian is introduced. (tr-auth)

**30394** A NOTE ON THE MAGNETOHYDRODYNAMIC TWO-LAYER VISCOUS STRATIFIED FLOW DOWN AN INCLINED PLANE. Sinha, D. K. (Jadavpur Univ., Calcutta). Ind. J. Theor. Phys., 15: 75-9 (Sept. 1967).

A study was made of 2-layer viscous stratified flow of liquid down an inclined plane as extended by the addition of a magnetic field. The problem is nonlinear, but is linearized by neglecting higher powers. To facilitate the solution of the problem, Laplace transforms of the fundamental equations of the problem and of the boundary conditions are introduced. Because of the difficulties of inverse Laplace transformations, velocity values are restrained to small values of time. After necessary approximation, it was shown that $m_1$, $m_2 \simeq Ap^{\frac{1}{2}}$, $Bp^{\frac{1}{2}}$, where A and B are constants depending on the viscosity and density of the liquid and, $m_1$ and $m_2$ are roots defined by another expression. With simplifying assumptions for small values of time, an expression is obtained which can be transformed inversely, provided necessary restrictions on A and B are imposed. (BBB)

**30395** SHOCK WAVES AND COMPRESSIBILITY HYPOTHESIS IN RELATIVISTIC MAGNETOHYDRODYNAMICS. Lichnerowicz, Andre (Coll. de France, Paris). Commun. Math. Phys., 12: 145-74 (1969). (In French).

It is shown that the normals to the hypersurfaces in space-time that represent the shock waves of relativistic magnetohydrodynamics are spacelike when the caloric equation of state of the medium satisfies the conditions of compressibility previously given. Thus, the velocities of these waves are less than the local velocity of light and the theory is consistent with the postulates of a relativistic theory. A theorem previously given (Ann. Inst. Henri Poincaré, 5: 37(1966)) concerning the stability of Alfvén shock waves is corrected in this paper. (auth)

**30396** MAGNETOHYDRODYNAMIC LAMINAR FLOW BETWEEN POROUS DISKS FOR LARGE INJECTION REYNOLDS NUMBER. Rudraia, N.; Chandarsekkhara, B. S. (Tbilisi Inst. of Power Engineering, USSR). Soobshch. Akad. Nauk Gruz. SSR, 53: 285-8 (Feb. 1969). (In Russian).

The steady flow of an incompressible conducting fluid between two parallel circular porous disks with an applied magnetic field transverse to the plane of the disks is considered. The equations of motions are solved using the techniques of inner and outer expansions. The expressions for velocity, pressure, and shear stress distribution are obtained for large injection Reynolds number and large Hartmann number. (auth)

## Geophysics (Upper Atmosphere)

*Refer also to abstract 30262.*

**30397** (CSIR-271) A THEORETICAL INVESTIGATION OF THE F REGION OF THE IONOSPHERE. Torr, Marsha R.; Torr, D. G. (Council for Scientific and Industrial Research, Pretoria (South Africa). National Inst. for Telecommunications Research). 1969. 86p. Dep.

A common shortcoming of current F region theories is that the resultant electron density peaks are too small by a factor of 2 to 4. In this paper the current observational data concerning electrons precipitated into the ionosphere are examined critically. It is shown that the experimental evidence favoring the theory that particles produce a marked effect on the ionosphere is steadily mounting and is strengthened by the results obtained by solving the time-dependent ionospheric continuity equation, taking into consideration the effects of an influx of energetic electrons (0.05 to 2 keV), atmospheric winds, and thermal nonequilibrium and nonlinear recombination-type loss processes. It is found that inclusion of a corpuscular source of ionization offers an explanation for the behavior of the quiet F layer, for its maintenance during the night, and for certain ionic distributions observed at a high- and a mid-latitude station. Various other phenomena are also examined and mechanisms are found which offer an explanation for certain types of ionospheric disturbances. In particular, it is found possible to explain the midday bite-out and early-morning maxima in electron density observed at certain stations in summer, using laboratory measured values of the various reaction rates and of the coefficient of ambipolar diffusion (collision cross section). Furthermore, the observed variations in electron density are explained without altering the phase of the diurnal variation in the atmospheric winds. It is found that the diurnal variation in precipitated electron flux must follow the solar ultraviolet diurnal variation fairly closely. 206 references. (auth)

**30398** (JPRS-47897) MEASUREMENTS OF RADIATION EFFECTS OF THE AMERICAN HIGH ALTITUDE THERMONUCLEAR BURST STARFISH ABOARD THE KOSMOS-6 SATELLITE. Shafer, Yu. G.; Bolyunova, A. D.; Gal'perin, Yu. I.; Kulagin, A. G.; Petrishcheva, I. S. Translated from Kosm. Issled., 6: 877-86 (Nov.-Dec. 1968). 14p. CFSTI.

The results of measurements of the effect of the American thermonuclear burst on July 9, 1962 on board the Kosmos-6 satellite are analyzed. The conclusions that radioactive products of the burst are adsorbed on the surface of the satellite during its movement through the charged upper atmosphere obtained earlier by the data of Kosmos-5 and Kosmos-3 are confirmed. Estimates of longitudinal drift velocity of the high-energy fragments adsorbed on the hull of the satellite during the first hour after detonation were made. According to these estimates an average velocity of inertial divergence of the plasma cloud particles $v_\infty \gtrsim 1.4 \times 10^8$ cm/sec was obtained. Within the limits of error this estimate agrees with the velocity obtained from experimental measurements by the time of occurrence of fission fragments in the adjacent region. It is demonstrated that a portion of the fragments remained for a prolonged period of time (on the order of several weeks) at altitudes near the maximum of the F region of the ionosphere, and the average concentration of fragments along the orbital path at the flight altitudes of the satellite (250 to 350 km) was 0.1 to 0.01 fissions/cm$^3$ during this period. (auth)

**30399** (N-69-19649) GLOBAL OBSERVATIONS ON THE THERMAL BALANCE OF THE NIGHTTIME PROTONOSPHERE. Mahajan, K. K.; Race, L. H. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec. 1968. 26p. (NASA-TM-X-63459; X-621-68-506). CFSTI.

Alouette 2 electrostatic probe measurements of the nighttime electron temperature ($T_e$) and concentration ($N_e$) in the height range 2500 ± 500 km are presented on global basis (−60 to +60 geomagnetic latitude). The major feature of the protonosphere at this altitude is an electron temperature trough of the order of 1800°K at the low latitudes, increasing sharply to over 3000°K at the middle latitudes. The electron concentration exhibits a pair of maxima at about 30° north and south with values ranging from $4 \times 10^3$/cc in fall to $8 \times 10^3$/cc in local summer. No definitive seasonal dependence is apparent in $T_e$. Comparison of the present Alouette 2 measurements with nearly simultaneous measurements on Explorer 22 during summer 1966 reveal a field-aligned positive temperature gradient in $T_e$. Typical gradients at 1000 km are 0.5°/km on the 35° field line and 1.0°/km on the 50° field line. These gradients are consistent with the thermal energy stored in the nocturnal protonosphere and, therefore, no external source of heat is required to explain the observations. (auth) (STAR)

**30400** (N-69-19850) RADAR BACKSCATTER AND ROCKET PROBE MEASUREMENTS OF ELECTRON TEMPERATURE ABOVE ARECIBO. Brace, L. H.; Carlson, H. C.; Mahajan, K. K. (National Aeronautics and Space Administration, Greenbelt, Md. God-

dard Space Flight Center). Dec. 1968. 11p. (NASA-TM-X-63477; X-621-68-482). CFSTI.

The backscatter and probe measurements were correlated to uncover and investigate any systematic differences between the two methods. Double-pulse radar observations were taken before and after each of the two rocket flights and an additional observation was centered on the time of launch of the night flight. At altitudes below 180 km and above 240 km for the day flight, the measurements agreed to within 5%. Agreement above 286 km for the night flight is within 10%, with the radar values systematically lower. The difference evident only at night could not be attributed with certainty to either a variability of the ionosphere or a real experimental error in either or both methods. Conflicting results of similar intercomparison experiments are presented and examined. (STAR)

**30401** (N-69-19921) DOCUMENTATION OF EXPLORER 32 ELECTRON TEMPERATURE MEASUREMENTS USED IN COMPARISONS WITH BACKSCATTER MEASUREMENTS AT JICAMARCA. Brace, L. H.; Dyson, P. L. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1968. 25p. (NASA-TM-X-63476; X-621-68-469). CFSTI.

A series of Explorer 32 satellite passes over Jicamarca provided direct measurements of electron temperature that disagree significantly with those derived from radar backscatter data. The Explorer 32 electrostatic probe experiments are briefly described; experimental data from which the satellite values of electron temperature were derived are presented; the analysis procedure is outlined; and the known sources of random and systematic error are discussed. It is concluded that the excellent quality of the data, the linearity of the $\log_e I_e$ plots over nearly two decades of electron current, and the agreement between the values derived from the two independent probe experiments make it difficult to understand how the probe-derived temperatures could be in error by a factor large enough to explain the disagreement with backscatter data. (auth) (STAR)

**30402** (N-69-19936) COMPARISONS BETWEEN TOPSIDE AND GROUND-BASED SOUNDINGS. Jackson, John E. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar. 1969. 40p. (NASA-TM-X-63474; X-615-69-79). CFSTI.

Past observations indicating that electron density profiles derived from topside ionograms have a tendency to be slightly too low, are reviewed and discussed. This problem is then examined in the light of more recent and better controlled experiments in which vertical electron density profiles were obtained essentially simultaneously by topside and ground-based soundings. These new measurements confirmed past observations and indicated that the error had a tendency to increase with satellite altitude. From a study of the ground echoes, which are often seen on topside ionograms, it is shown that the above discrepancies can be partially attributed to systematic errors (0 to +30 km) in the topside ionogram height markers. (auth) (STAR)

**30403** $\phi_{F_2}$: THE IONOSPHERIC INDEX DEFINED BY COMPUTER. Joachim, M. Telecommun. J., 35: 678-9(Dec. 15, 1968).

The author previously proposed the use of a new ionospheric propagation index based on the correlation between ionospheric data (noon values of $f_0F_2$ at 9 different stations) and the solar index $\phi$ (solar radio noise at 2800 MHz). The unit of $\phi$ is the Jansky, where 1 Jansky = $10^{-22}$ W/m$^2$ Hz units. Later, a study was made of the curvilinear correlation between the ionospheric and solar values and also whether it was necessary to have 3 more ionospheric stations in the Southern Hemisphere to give a more even distribution of stations in the 2 hemispheres. Pending the outcome of these decisions, the author prepared a computer program for automatically establishing the curvilinear correlation between the solar and ionospheric values. The program gives the regression curve parameters for each month and station as well as the standard deviations $\sigma_\phi$ in percentage and $\sigma_f$ in MHz. An example of the results observed for one month of the year is given. If the values of $\phi_{F2}$ supplied by the first run through the computer are used as a basis for the correlation, $\phi_{F2}$ is obtained from the second run, these values give $\phi_{F2}$ from the third run, and so on. It was noted that the values of $\sigma_\phi$ diminish with each run, while the values of $\sigma_f$ in MHz remain substantially the same. (BBB)

**30404** UNIVERSAL COMPONENTS OF $F_2$ LAYER CRITICAL FREQUENCY. Lal, Chaman (Government of India, New Delhi). Telecommun. J., 35: 671-6(Dec. 15, 1968).

It is shown that in spite of complicated changes which the F2 layer critical frequency manifests, it is possible to construct on a systematic basis the diurnal patterns of $f_0F2$ at almost any place, at any season or epoch of the solar cycle with reasonably accuracy with 4 basic components which can be physically significant. Functionally, these components can be designated as a cos $\phi$ component, a semi-diurnal component, a zonal component, and a meridional component. All these components are simple sinusoidal functions with or without a superimposed constant value. An integration of these basic components in proper proportions and order can provide a universal formula for the F2 layer critical frequency. A universal formula based on such an analysis may provide an insight into the causes and mechanisms which bring about the observed complicated changes in $f_0F2$ and may lead to the formulation of an acceptable theory for the formation of the F2 layer. Additionally, it may also throw significant light on several related solar-terrestrial and geophysical phenomena. Examples are shown of computed and observed characteristics at a number of stations covering the period of 1954 to 1957. (BBB)

**30405** SCIENTIFIC RESULTS OBTAINED WITH SATELLITE FR-1. Telecommun. J., 35: 648-9(Dec. 15, 1968).

The aim of the French satellite FR-1 was to study the propagation of very low frequency waves between the Earth and the magnetosphere, especially the influence, if any, of irregularities in the magnetospheric plasma. To that end, the satellite was equipped with antennae and receivers for measuring the 3 magnetic components and 2 of the 3 electric components of the vlf field in the magnetosphere. The test results for the vlf field level were compared with the theoretical forecasts made before the satellite was launched. The test results confirmed the validity of the forecasts both as regards the mean level, showing a north-south effect of about 10 dB, and the large-scale horizontal field fluctuations (>200 km), these being due to interference in the Earth-ionosphere duct. However, good agreement for the night results could only be obtained by assuming that there was a certain persistence, during the night, of ionization in the D layer at a height of 70 to 90 km. Instead of the expected grouping of the directions of wave perpendiculars around the vertical, an almost systematic refraction of the perpendiculars towards the equator was observed together with a marked scattering of their directions in connection with the irregular variations of the vlf field measured by the satellite. The explanation of this anomaly is that it results from the influence of the large-scale horizontal gradients of electron density in the ionosphere. (BBB)

**30406** MAGNETIC CAVITY DUE TO LINE CURRENTS IN A PLASMA. Kambe, Tutomu (Tokyo Univ.). Inst. Space Aeronaut. Sci., Univ. Tokyo, Rep., No. 433, 409-22(Dec. 1968).

Investigations attempting to determine the shape of the cavity generated by the Earth's magnetic field in the interplanetary plasma are discussed, and an approach was made to evaluating the shape of 2-dimensional cavity formed in a plasma by the effect of the magnetic field due to several parallel line currents. A rigorous treatment based on conformal transformation is given. It was shown that the method of conformal transformation developed by Imai to study the 2-dimensional irrotational motion of an incompressible perfect fluid with free surface can be applied to the present case with a slight modification. By this method it was possible to determine rigorously the shape of 2-dimensional magnetic cavity and magnetic lines of force due to parallel line currents in a plasma. The exact shape of the cavity was determined for the case of 2 or 4 line currents and for their limiting cases which represent a magnetic dipole and quadrupole. The cavity produced by a magnetic dipole is of the form of the cross section of an apple cut by a plane including its symmetry axis. The results obtained could also be applied to the cases of suitable combination of perfectly conducting plates and line currents. The method can be used for more general cases. (BBB)

**30407** GEOMAGNETIC PULSATIONS AND MAGNETOSPHERE DIAGNOSTICS. Troitskaya, V. A.; Gul'elmi, A. V. (Inst. of Terrestrial Physics, Moscow). Usp. Fiz. Nauk, 97: 453-94(Mar. 1969). (In Russian).

The ultralow-frequency electromagnetic waves, called geomagnetic pulsations, were systematically studied for the first time during the 1957-58 International Geophysical Year. They consist of hydromagnetic waves with a frequency spectrum within the millihertz to kilohertz range. The lower boundary of the spectrum coincides with the shortest specific oscillation of the magnetosphere, the upper boundary lies at the gyrofrequency of protons in the lower layers of the polar ionosphere. The pulsations represent an indirect indication about the existence of hydromagnetic waves in the terrestrial magnetosphere. They yield information on the parameters of the magnetosphere and solar corpuscular streams. Study of the pulsations may serve as a diagnostic tool for determining the properties of the interplanetary medium. All geomagnetic pulsations are generated by the instability of the cosmic plasma surrounding the Earth; the ultralow-frequency radiation is due to kinetic instabilities of the propagation of energetic particles, while the long-wavelength pulsations are attributed to hydrodynamic instabilities, such as the passage of

solar wind in the magnetosphere. Many satellite, space-probe, and surface experiments have been carried out; valuable information has been gained from the study of atmospheric static concerning the concentration of plasma in the magnetosphere. (158 references) (TTT)

**30408** RELATION BETWEEN THE F REGION AND THE E, LAYER. Gorinov, N. (Inst. of Geophysics, Sofia). Compt. Rend. Acad. Bulg. Sci., 22: 145-7(1969).

A method of analysis is proposed, seeking the coefficient of correlation between the changes of the critical frequency of the F2 layer and the maximal frequency of the $E_s$ layer. For this purpose, a statistical treatment was made of the available ionograms observed for five minutes at the stations of Sofia ($\varphi$ = 42° 41′ N; $\lambda$ = 21° 23′ E), Michurin ($\varphi$ = 42° 10′ N; $\lambda$ = 27° 52′ E); Moscow ($\varphi$ = 55° 30′ N; $\lambda$ = 37° 20′ E) and Leningrad ($\varphi$ = 59° 57′ N; $\lambda$ = 30° 42′ E). (M.O.W.)

**30409** EXPERIMENTAL STUDY OF THE PERTURBATION PRODUCED IN THE IONOSPHERE BY A STRONG GROUND EXPLOSION. Berthoumieu, Henri; Broche, Pierre; Delloue, Jean; Garnier, Michel (Faculte des Sciences, Paris). Compt. Rend., Ser. A, B, 268: 518-20(Feb. 10, 1969). (In French).

An experiment is described showing the Doppler effect sustained by a ten-meter radio wave at the time of the passage through the ionosphere of an acoustic wave produced by a strong ground explosion. The results are interpreted and shown to be in agreement with a nonlinear theory for the propagation of acoustic waves. (tr-auth)

**30410** EVIDENCE OF MONOENERGETIC BEAMS DURING PRECIPITATION OF AURORAL ELECTRONS. Barria, Daniel; Maral, Gerard (CNRS, Toulouse). Compt. Rend., Ser. B, 268: 893-6(Mar. 24, 1969). (In French).

An experiment with a balloon provided the energy spectrum of x rays created by the bremsstrahlung of electrons high in the atmosphere. The primary electron spectrum deduced from it shows the presence of a monoenergetic beam with energy of about 130 keV and with a duration of ten minutes. (tr-auth)

**30411** SIMULTANEOUS GEOMAGNETIC AND COSMIC NOISE ABSORPTION PULSATIONS NEAR GEOMAGNETIC NOON. Yuan, F. F. F.; Jacka, F. (Univ. of Adelaide). Nature (London), 222: 653-4(May 17, 1969).

Using balloon-borne instruments in the northern auroral region, pulsating electron precipitation events were observed near local noon, associated with geomagnetic pulsations of type Pc3 (continuous pulsations with periods of 10 to 45 sec). This communication describes pulsation events, believed to be of the same basic type, recorded with ground-based instruments (riometer and geomagnetic micropulsation sensor) at Macquarie Island in the southern auroral region, occurring near local geomagnetic noon. It is suggested that the sudden onset and short duration of the cosmic noise absorption pulses were the result of precipitation of short bursts of electrons into the ionosphere. (UK)

**30412** IONOSPHERIC IRREGULARITIES AND THE CROSS-FIELD PLASMA INSTABILITY. Tsuda, Takao (Kyoto Univ. National Center for Atmospheric Research, Boulder, Colo.); Sato, Tetsuya; Matsushita, Sadami. J. Geophys. Res., 74: 2923-32 (June 1, 1969).

Results of an extensive study on the cross-field instability in weakly ionized gases are presented. They are responsible for some charge density irregularities of the midlatitude and equatorial ionospheric E region. Both a linear one-dimensional case and a nonlinear two-dimensional case are formulated and numerically investigated with computers. All these cases strongly support the formation of ionospheric irregularities by the mechanism of cross-field instability. Whether or not the model irregularities are bounded versus height, weak perturbations rapidly grow to large-amplitude plasma turbulence with fluid-like charge density fluctuations of very low frequency (typically of 10 Hz) and long wavelength (of the order of 100 meters). (auth)

**30413** SUNLIGHT PHOTODETACHMENT RATE OF GROUND STATE $O_2^-$. Woo, S. B. (Univ. of Delaware, Newark); Branscomb, L. M.; Beaty, E. C. Contract DA-31-124-ARO-D-139. J. Geophys. Res., 74: 2933-40(June 1, 1969).

The rate of photodetachment of $O_2^-$ was determined in white light and the rate adjusted to yield a value for the lifetime of $O_2^-$ in sunlight. The technique used was to measure the rate of production of free electrons from ions in a buffer gas of pure oxygen. The buffer gas pressure was high enough to permit any vibrational or electronic excitation to be relaxed by ~$10^6$ collisions with the 300°K oxygen molecules. Identification of the ions was by determination of their mobility. The sunlight photodetachment rate, as determined by the measurement, is 0.3 ± 0.1/sec. The only previous measurements were more controlled in most respects, but they were made on ions with an unknown amount of excitation. Having ions that are relaxed makes the data more relevant for use in applications to the mesosphere. There is the risk that $O_2^-$ reacts with oxygen to make $O_4^-$. If this is true in the present measurement, it is likely to be true in applications also. (auth)

**30414** ELECTRON MEASUREMENTS BEARING ON THE ENERGY AND PARTICLE BALANCE OF THE UPPER F REGION. Brace, L. H.; Mayr, H. G.; Findlay, J. A. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 74: 2952-61(June 1, 1969).

Electron temperature and density profiles measured between 120 and 630 km at midday at Wallops Island on March 2, 1966, are presented and interpreted. The temperature profile exhibits a strong positive gradient (24°/km) below 150 km followed by a smooth transition to a much smaller positive gradient (1.5°/km) above 300 km. Between 300 and 400 km, the electron concentration decreases with a scale height of about 100 km, which is significantly lower than the diffusive-equilibrium scale height for the observed temperatures. Furthermore, the scale height more than doubles between 400 and 500 km. This change in scale height in a region where the mean ion mass and the electron temperature are nearly constant is also inconsistent with diffusive equilibrium and suggests that some dynamic process was occurring at the time of the flight. A simultaneous solution of the particle and energy continuity equations for the F region is carried out with the aid of inputs and boundary conditions from measurements of neutral composition, neutral gas temperature, and ion composition from the same vehicle. This analysis permits one to conclude that the upper F region was not in diffusive equilibrium between 300 and 500 km and that the low plasma scale height at these altitudes was consistent with either a neutral atmospheric wind or a rapid temporal variation in $O^+$ (auth)

**30415** PENETRATION OF SOLAR ENERGETIC PROTONS INTO THE MAGNETOTAIL. Montgomery, Michael D.; Singer, S. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res., 74: 2869-80(June 1, 1969).

Using the proton data collected by the Vela 4 energetic particle telescopes during the period May 21–June 8, 1967, a comparison has been made of the 0.7- to 40-MeV proton fluxes inside and outside the magnetotail at 19 $R_E$. This comparison has yielded information pertaining to the mechanism by which protons can enter the magnetotail. Measurable delays in the propagation of sudden flux changes into the magnetotail were always observed, and they varied between 15 minutes and 2 hours; most delays were between ½ and 1 hour. Some fluctuations were smoothed or broadened by an amount comparable to the delay time, but the longer-delay events were frequently not significantly smoothed. The delays were at best weakly energy dependent, and smoothing was most pronounced at the lowest proton energies. The fluxes inside the magnetotail or within ~1 $R_E$ of the magnetopause were much more isotropic than those farther from the magnetopause or in the interplanetary medium. A comparison of these results with diffusive (multiple scattering) and free access (open tail) mechanisms reveals areas of disagreement with both: a long diffusion delay time and its dependence on the inverse of the particle energy are not observed, and the magnitude of the delays suggests that field line interconnection near the Earth is not an important source of magnetotail protons. It is concluded that the observations may be explained by a combination of multiple scattering near and within the magnetotail and merging of the Earth's magnetic field with the interplanetary field far (~1000 $R_E$) downstream. (auth)

**30416** NONUNIFORMITY OF SOLAR PROTONS OVER THE POLAR CAPS ON MARCH 24, 1966. Hudson, P. D.; Anderson, H. R. (Rice Univ., Houston, Tex.). Contract NAS 5-9317. J. Geophys. Res., 74: 2881-90(June 1, 1969).

Observations of ~10-MeV protons were made over the polar regions by an ionization chamber during two solar proton events on March 24, 1966, which were separated by ~3.5 hours. Short-term fluctuations in the ionization were observed with factor of 2 changes occurring in ~30 sec or ~220 km. A nearly identical ionization chamber at 10 to 16 $R_E$ sunward observed no short-term fluctuations, and these differences are interpreted as spatial effects due to the field structure over the poles. The fluctuations occur mainly when the proton density outside the magnetosphere is increasing rapidly (by a factor of 2 per ~10 minutes) and when the flux is highly anisotropic. Most of the fluctuations disappear in ~2 hours, but similarities between the fluctuations observed during the two solar proton events suggest that the modulation is not interplanetary in origin, and that the magnetospheric field structure causing the modulation retains the same pattern for a period of 3.5 hours. The fluctuations may be due to particles following different paths through the magnetosphere and connecting to different parts of the anisotropic flux behind the bow shock. (auth)

**30417** AURORAL ABSORPTION OCCURRENCE PATTERNS AS A FUNCTION OF MAGNETIC ACTIVITY. Shepherd, Donald C.; Ecklund, Warner L. (ESSA Research Labs., Boulder, Colo.). J. Geophys. Res., 74: 2891-8(June 1, 1969).

Auroral absorption occurrence patterns that can be simply mapped onto the magnetotail have been developed as a function of Kp. The resulting polar plots show several interesting features. One is the occurrence of intense absorption events at about 60° geomagnetic latitude near noon under relatively quiet magnetic conditions. A more interesting feature appears in the night sector where the pattern of intense absorption occurrence divides into two distinct regions with increasing longitudinal separation as Kp increases. From this observation it is inferred how the width of the magnetotail neutral sheet source changes as a function of Kp. (auth)

**30418** STOCHASTIC HEATING OF PROTONS BY FAST HYDROMAGNETIC WAVE. Hollweg, Joseph V. (Max-Planck-Institut fuer Extraterrestrische Physik, Munich). J. Geophys. Res., 74: 2899-2907(June 1, 1969).

The stochastic heating of protons by a random magnetosonic wave propagating normal to the magnetic field is suggested as an explanation of the observation that the protons are hotter than the electrons in the plasma sheet of the magnetotail. A perturbation analysis is used to find the proton trajectories under the influence of the electric and magnetic fields of the driving wave. The gradients of the field quantities across a proton orbit are included by using the first term in a Taylor series expansion. The inclusion of the field gradients and particle drifts gives the result that the heating depends not only on the energy in the wave spectrum at the gyrofrequency but also on that at the first harmonic of the gyrofrequency, and suggests, furthermore, that the faster protons are heated more strongly with the result that their distribution function can be broadened, consistent with observation. A nonlinear mechanism that can decouple the particles from the wave is suggested, and it is shown to yield proton energy gains of the correct order of magnitude for the plasma sheet. (auth)

**30419** CAUSES OF SUDDEN COMMENCEMENTS AND SUDDEN IMPULSES. Burlaga, L. F.; Ogilvie, K. W. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 74: 2815-25(June 1, 1969).

The causes of 19 worldwide changes in the Earth's magnetic field, occurring between June and December 1967, were determined by examining magnetic field and plasma data for the solar wind near the Earth. Seven of the events were classified as storm sudden commencements (ssc) and 4 as sudden impulses (si) by most stations reporting them. All of the ssc's were caused by hydromagnetic shocks. Two of the si's were negative impulses ($si^-$) and were caused by tangential discontinuities across which the density decreased. The other 2 si's were distinct pulses in the magnetograms, for which the designation $pi^+$ is suggested, and were caused by dense spots in the solar wind with dimensions $\approx 0.005$ AU. There was no consensus among the reporting magnetic observatories as to whether the remaining 8 events should be called si's or ssc's. Five of these events were caused by shocks and the other 3 by tangential discontinuities in the solar wind, but there seems to be no sure way to predict the type of structure from the shape of the magnetogram pulse. The rise time of the impulse in the H component in the magnetogram is apparently determined by something other than the type, the speed, or the thickness of an interplanetary discontinuity that caused the event. (auth)

**30420** HORIZONTAL GRADIENTS IN THE POLAR IONOSPHERE. Titheridge, J. E. (Univ. of Auckland, N. Z.). J. Geophys. Res., 74: 3049-53(June 1, 1969).

The 20-, 40-, and 41-MHz signals from the S-66 satellite have been recorded at Scott Base since Oct. 1964. In this note measurements obtained during 5000 transits were used to investigate the large-scale horizontal gradients that occur in the total electron content of the Antarctic ionosphere at sunspot minimum and sunspot maximum. (W.D.M.)

**30421** ION, ELECTRON, AND NEUTRAL TEMPERATURES DERIVED FROM ION COMPOSITION DISTRIBUTION. Rao, B. C. Narashinga (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 74: 3054-7(June 1, 1969).

Recently Brinton et al. (1969) reported the positive ion mass spectrometer measurements obtained from the Geoprobe (Argo D-4) over an altitude range of 200 to 630 km at 1300 EST on March 2, 1966 above Wallops Island. The ionic constituents measured were $O^+$, $N^+$, $H^+$, $He^+$, $NO^+$, $O_2^+$, and $N_2^+$. The measurements showed $O^+$ as the major constituent throughout the altitude range. Since the distribution of each ionic species is controlled by diffusive processes at higher heights and chemical processes at lower heights with an overlap in the intermediate heights [Bauer, 1964], it is possible to derive the ion, electron, and neutral temperatures from the composition data using the appropriate expressions. (W.D.M.)

**30422** PLASMA FLOW PATTERN IN THE EARTH'S MAGNETOSHEATH. Hundhausen, A. J.; Bame, S. J.; Asbridge, J. R. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res., 74: 2799-2806(June 1, 1969).

Positive-ion observations made on the twin Vela 3 satellites were used to study the plasma flow pattern in the "twilight" regions (near 90° from the subsolar point) of the magnetosheath. Observations from January to May 1967 reveal a persistent deviation from symmetry about the Sun–Earth line. Both simultaneous measurements by satellites on opposite sides of the magnetosheath and long-term averages indicate a flow pattern whose line of symmetry makes an angle of 8° ± 1° with the Sun–Earth line, and ~6° with the direction of the incident solar wind. This tilting of the flow pattern is in good agreement with Walters' 1964 prediction of the effect of the interplanetary magnetic field on the post-bow shock flow pattern. (auth)

**30423** THEORY OF AN ELECTRON TRAP ON A CHARGED SPACECRAFT. Whipple, Elden C. Jr. (Environmental Science Services Administration, Boulder, Colo.); Parker, Lee W. J. Geophys. Res., 74: 2962-71(June 1, 1969).

A theory is developed for the behavior of an electron trap on a slowly moving charged spacecraft in the limit of large Debye length and no magnetic field. Analytic expressions are obtained for the current to an aperture electrode and to an internal retarding electrode for all values of aperture and spacecraft potentials. When the spacecraft is repulsive and the aperture grid is less repulsive (or even attractive), a potential barrier exists that reduces the current. The extent of the reduction can be orders of magnitude. As a consequence, the "knee" in the current–voltage curve can yield incorrect values for the electron concentration and spacecraft potential if conventional Langmuir probe theory is used. When the spacecraft is more attractive than the aperture grid, the current is unaffected by the spacecraft potential. It is shown that in the so-called exponential regime of the retarded current, it is impossible for secondary electrons to reach the collector from the adjacent external surfaces of the spacecraft. In the attractive regime the current characteristic is linear for large aperture potentials. (auth)

**30424** VERTICAL-INCIDENCE PULSE DISPERSION WITH APPLICATIONS TO THE ALOUETTE 1 TOPSIDE SOUNDER. Watt, T. M. (Stanford Research Inst., Menlo Park, Calif.). J. Geophys. Res., 74: 2972-81(June 1, 1969).

It is well-known that pulse dispersion has inhibited the full exploitation of topside sounder ionograms. This dispersion has its greatest effect in severe widening of the initial, close-in echoes appearing on any given ionogram. The resulting large scaling uncertainties lead to correspondingly large uncertainties in deduced values of parameters, such as plasma scale height, in the vicinity of the sounder. In this study, vertical incidence pulse dispersion is considered in general, using simple, tractable expressions for system parameters. Relationships are established between echo width, sounder system bandwidth, and the frequency gradient of ionospheric virtual height. The results are applied to a particular Alouette 1 sounding, and practical applications are discussed. (auth)

**30425** DISTORTION OF AN ELF PULSE AFTER PROPAGATION THROUGH AN ANTIPODE. Wait, James R. (ESSA Research Labs., Boulder, Colo.). J. Geophys. Res., 74: 2982-6(June 1, 1969).

Propagation of the slow tail portion of atmospheric waveforms is considered. Using an idealized model of the Earth–ionosphere cavity, the transient fields are calculated for a pulse-excited electric dipole source. It is shown that the frequency-independent phase shift at the antipode will lead to a pronounced change in the observed shape of the atmospheric waveform. (auth)

**30426** A POSSIBLE FULL-MOON ENHANCEMENT OF HYDROMAGNETIC EMISSION ACTIVITY. Fraser-Smith, A. C. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). J. Geophys. Res., 74: 2987-95(June 1, 1969).

Micropulsation records obtained at California stations during a 6-year period, from August 1, 1960, to July 30, 1966, have been analyzed for a possible full-Moon effect on hydromagnetic (hm) emission activity. The data, which had previously been digitized into the form of a daily hm emission activity index W, were considered in both their original form and then according to several selection criteria. For example, geomagnetically quiet intervals ($\Sigma Kp < 30$ for each day) containing a full Moon were analyzed, as well as similar intervals when the Moon's ecliptic latitude, $\beta$, was

restricted to values $\beta \leq 3.5°$. Also analyzed were days when a full Moon occurred during a well-defined geomagnetic storm. In all cases there was an indication of an enhancement of hm emission activity commencing the day before full Moon and, at least in the case of storm days, extending into the full-Moon day. A full-Moon effect on the Kp index has been previously suggested but, as in the present case, there were insufficient statistics to establish the effect beyond doubt. This new result for hydromagnetic emissions provides additional evidence for a small lunar disturbance of the magnetosphere around the time of the full Moon. (auth)

**30427** BANDED CHORUS: A NEW TYPE OF VLF RADIATION OBSERVED IN THE MAGNETOSPHERE BY OGO 1 AND OGO 3. Burtis, W. J.; Helliwell, R. A. (Stanford Univ., Calif.). Contract NAS 5-2131. J. Geophys. Res., 74: 3002-10(June 1, 1969).

Satellites OGO 1 and OGO 3 observe vlf discrete emissions in the magnetosphere primarily in a single, variable frequency band. The frequency f of this "banded chorus" depends on the equatorial electron gyrofrequency $f_{H_e}$ for the field line passing through the satellite, typical ratios of $f/f_{H_e}$ being 0.2 to 0.5. Evidently the emissions are produced near the equator at a fraction of the electron gyrofrequency, as predicted by electron cyclotron resonance generation mechanisms. A secondary dependence of the banded chorus frequency on dipole latitude, such that the lower ratios of $f/f_{H_e}$ are found at higher latitudes, is interpreted to mean that the emissions are generated at about half the electron gyrofrequency, but deviate inward from the field line to lower L values as they propagate earthward. Theoretical support is given by ray tracings showing the inward deviation of nonducted whistler-mode radiation due to the curvature of the magnetic field. Banded chorus has been observed at all local times, but is most common in the morning magnetosphere, outside the plasmapause. (auth)

**30428** ELECTRON COOLING BY VIBRATIONAL EXCITATION OF $O_2$. Lane, N. F. (Rice Univ., Houston, Tex.); Dalgarno, A. J. Geophys. Res., 74: 3011-12(June 1, 1969).

Electron-cooling rates by vibrational excitation of molecular oxygen are calculated as a function of electron temperature. In the E region, the heat loss by vibrational excitation of molecular oxygen is about 20% of the total heat loss. (auth)

**30429** PROTON ENTRY INTO THE MAGNETOSPHERE ON MAY 26, 1967. Williams, D. J. (Goddard Space Flight Center, Greenbelt, Md.); Bostrom, C. O. Contract NOw 62-0604-c. J. Geophys. Res., 74: 3019-26(June 1, 1969).

Low-energy proton observations over the polar cap and in the interplanetary and magnetosheath regions are compared during May 26, 1967. The results indicate that at this time the entry of low-energy solar protons into the magnetosphere was controlled by a diffusion process. It also appears that the protons had access to the entire figure-8 current pattern in the geomagnetic tail and diffused into the two approximately circular cylinders containing the field lines from the northern and southern polar caps. A first approximation value of $10^{15}$ to $10^{16}$ $cm^2$ $sec^{-1}$ is obtained for the radial diffusion coefficient, $D_{rr}$, in the tail. No value can be derived for the diffusion coefficient along the field line, $D_{zz}$, with the present data. Consequently, in the present case, only a rough upper limit of $L \leq$ (420 to 2400)$R_E$ is obtained for the distance to the region where low-energy protons are diffused into the tail. (auth)

**30430** MAGNETIC EMISSIONS IN THE MAGNETOSHEATH AT FREQUENCIES NEAR 100 Hz. Smith, Edward J. (California Inst. of Tech., Pasadena); Holzer, Robert E.; Russell, Christopher T. Contracts NAS 7-100; JPL 950403. J. Geophys. Res., 74: 3027-36(June 1, 1969).

Intense, sporadic bursts of narrow-band magnetic noise in the magnetosheath with frequencies near 100 Hz are reported. The signals were detected by search coil magnetometers on board OGO 1, OGO 3, and OGO 5. The tone-like bursts are superposed on the persistent, broadband, extremely low-frequency magnetosheath noise previously reported (Smith et al., 1967). (W.D.M.)

**30431** COMPARISON OF TWO GROUND-BASED D-REGION EXPERIMENTS. Cole, A. R.; Ferraro, A. J.; Lee, H. S. (Pennsylvania State Univ., University Park). Nature (London), 222: 761-3(May 24, 1969).

It is stated that the two most useful methods for studying ionospheric D-region electron densities are the partial reflection and the cross-modulation or wave interaction techniques. There has, however, been difficulty in obtaining agreement between the results of these two methods; this has been due partly to the different conditions, such as latitude and solar activity, relating to the comparison. The present communication compares results obtained when the two methods were used at the same location and almost simultaneously. There was remarkable agreement in the general shapes of the electron density profiles, and the electron density obtained by the partial reflection method never exceeded that given by wave interaction. It was proposed by Piggott and Thrane (J. Atmos. Terr. Phys., 28: 721(1966)) that the partial reflection theory should include possible irregularities in collision frequency and in electron density. The present data support this revised partial reflection theory. (UK)

**30432** PRODUCTION OF IONS AND ELECTRONS BY METEORITIC PROCESSES. Sida, D. W. (Carleton Univ., Ottawa). Mon. Notic. Roy. Astron. Soc., 143: 37-47(1969).

The ionization efficiency parameter, $\beta$, for meteoric atoms is discussed in the light of experimental results for ionization cross-sections. It is shown that $\beta$ varies rapidly with velocity v (as $v^n$, where $n \sim 5$). The values obtained are in good agreement with other recent determinations. Some inferences are made on this basis and it is shown that the distribution of ions in the upper atmosphere is not consistent with the idea that they are produced solely by this mechanism; thus the incoming meteors produce a source of mainly neutral atoms. However, it is shown that this ionization could be an important source for night-time sporadic-E ionization. (auth)(UK)

**30433** POLAR AND MAGNETOSPHERIC SUBSTORMS. Akasofu, Syun-ichi. Astrophysics and Space Science Library, Volume 11. New York, Springer-Verlag New York, Inc., 1968. 295p. $16.50.

This volume presents a synthesizing and unifying study of various polar upper atmospheric phenomena, such as auroral and magnetic activity and ionospheric storms, and shows that these complicated phenomena can be understood as manifestations of a single phenomenon which takes place intermittently in the magnetosphere — the magnetospheric substorm. The approach combines both upper atmospheric changes and the corresponding magnetospheric changes in an attempt to explain fundamental processes associated with the substorm. (W.D.M.)

**30434** DETERMINATION OF THE HEIGHT OF THE CURRENT SYSTEM EQUIVALENT TO THE LUNAR DIURNAL VARIATION OF THE GEOMAGNETIC FIELD. Bencze, Pal. Geofiz. Kozlem., 18: 13-18(1969). (In Hungarian).

The exact determination of the height of the current system equivalent to the lunar daily variation of the terrestrial magnetic field can be made from the dynamo hypothesis by the vertical (barometric) variation of the phase of the lunar semidiurnal component of the atmospheric tide. The latter variation is suitable for the interpretation of the data referring to the lunar semidiurnal variation of the ionosphere parameters. (auth)

**30435** STUDIES OF $\pi$-2 TYPE VARIATIONS OF ELECTROMAGNETIC FIELD AT MEAN LATITUDES. Hollo, Lajos Geofiz. Kozlem., 18: No. 1-2, 19-33(1969). (In Hungarian).

Morphological singularities of the $\pi$-2 type geomagnetic pulsations were studied in order to determine the relation of their amplitudes and periods to the solar and magnetic activity. An attempt was made to determine the amplitudes, period, and damping of $\pi$-2 pulsations as a function of the F-2 ionosphere. (tr-auth)

**30436** PLASMA FLOW AROUND THE MAGNETOSPHERE. Spreiter, John R.; Alksne, Alberta Y. (Ames Research Center, Moffett Field, Calif.). Rev. Geophys., 7: 11-50(Feb.-May 1969).

From International Symposium on the Physics of the Magnetosphere, Washington, D. C. See CONF-680956.

A review is provided of the salient features of the flow of solar plasma past the magnetosphere, as they are revealed by observations in space and by theory. Discussed first are the properties of the solar wind, including the velocity, density, temperature and temperature anisotropies, and magnetic field, and their variations in space and time as observed beyond the disturbing influence of the Earth and its magnetic field. Theoretical aspects of the steady-state interaction of the solar wind and the geomagnetic field are taken up next, using the continuum description provided by the equations of magnetohydrodynamics of a perfect dissipationless gas as a basis. An outline is given of the series of approximations, and their observational and theoretical justifications, used to reduce the complex free-boundary magnetohydrodynamic flow problem to a series of tractable problems; and a set of results is provided for representative conditions in the solar wind. The results are shown to be in good accord, even to numerous details, with observations made in space during quiet times. The results are also shown to be useful in interpreting many features of observations during disturbed times. Attention is drawn to other features of the flow of solar plasma past the magnetosphere for which quantitative theoretical descriptions must still be devised. These include the irregular or fluctuating character of the flow downstream of the bow wave, the nature of the magnetosphere tail and surrounding flow at great distances from the Earth, nu-

merous transient aspects of the flow, and the mechanisms underlying the many statistical correlations being discovered between variations of the surface geomagnetic field and various properties of the solar wind. (auth)

**30437** LABORATORY EXPERIMENTS RELATED TO THE SOLAR WIND AND THE MAGNETOSPHERE. Schindler, Karl (European Space Research Inst., Rome). Rev. Geophys., 7: 51-75(Feb.-May 1969).

From International Symposium on the Physics of the Magnetosphere, Washington, D. C. See CONF-680956.

The increasing number of laboratory experiments related to the solar wind and the magnetosphere calls for a critical review of the conditions under which a laboratory experiment can provide information about space phenomena. Naturally, the starting point is a discussion of the problem of physical similarity. For a unified presentation of the several sets of scaling laws that have been used, it is convenient to use the similarity laws of the Vlasov theory as a reference system. Clearly, the biggest obstacle for a strict reproduction of the solar-wind–magnetosphere interaction in the laboratory is collisional interaction. In the solar wind at the Earth's orbit, strict simulation is possible only for phenomena with a dimension of the order of a few hundred kilometers or smaller, such as the bow shock structure. A discussion of the existing terrella experiments shows that most of them obtain similarity by scaling the interplanetary field and the geomagnetic field differently. This determines the processes for which quantitative agreement can be expected, e.g., the shape of the frontal part of the cavity boundary and the approximate shape and position of the bow shock. Strict similarity can be achieved in simulating the structure of the bow shock wave. The overall ranges of the shock parameters of seven collision-free shock experiments discussed cover substantial parts of the bow shock parameter ranges. A comparative discussion of the magnetic-field profiles of the estimated shock width and of the appearance of oscillatory structures shows strong resemblances between space and laboratory observations. Several other experiments related to the solar wind and the magnetosphere are also listed. (auth)

**30438** QUANTITATIVE MODELS OF THE MAGNETOSPHERE. Roederer, Juan G. (Univ. of Denver). Rev. Geophys., 7: 77-96(Feb.-May 1969).

From International Symposium on the Physics of the Magnetosphere, Washington, D. C. See CONF-680956.

A clear understanding of the basic forms of motion of charged particles in the magnetic and electric fields of the outer magnetosphere is an essential ingredient to the study of the radiation belts and plasma. To achieve this, one must work with a reliable quantitative model of the magnetospheric field. The main purpose of any such model is to provide a mathematical description of the field that is reasonably accurate within a given spatial and temporal domain and that can be used to analyze in a quantitative way any process influenced or governed by this field in the corresponding domain. In this review, magnetic field models of the magnetosphere are critically examined and their fit to in-situ field measurements is discussed. Special attention is paid to the analysis of typical long-term time variations of the field configuration and the matching changes in model parameters. Implications for adiabatic particle motion, such as shell geometry, regions of pseudo-trapping, and adiabatic effects of slow time variations of the field, are analyzed. (auth)

**30439** GEOMAGNETIC TAIL. Ness, Norman F. (Goddard Space Flight Center, Greenbelt, Md.). Rev. Geophys., 7: 97-127(Feb.-May 1969).

From International Symposium on the Physics of the Magnetosphere, Washington, D. C. See CONF-680956.

The solar wind flows past the Earth and stretches the geomagnetic field behind it, forming a tail to the magnetosphere. Magnetic-field lines are directed toward the Sun in the upper half of the tail and oppositely directed in the lower half. The separation region where the field reversal takes place is occupied by an enhanced plasma flux, which keeps the oppositely directed fields from annihilating themselves. Satellite observations have also found intense transient electron fluxes within the plasma sheet region. Although the role of the tail in the magnetic substorm phenomena is not yet clear, during the main phase of a magnetic storm the tail appears to contribute significantly to the dynamical distortion of the magnetosphere, the decrease of the horizontal geomagnetic field on the Earth's surface, and the lowering of the latitude of the trapping boundary. Although the tail shows a well-defined theta geometry at 80 $R_E$, lunar orbit = 60 $R_E$, it has not been clearly observed at 500 and 1000 $R_E$. A radial gradient of the magnetic-field magnitude is consistent with merging occurring at the neutral sheet and with the tail length being of the order of 100 to 200 $R_E$. The basic mechanism for terminating the tail, as well as the means for momentum transfer on its boundary forming the tail, are not yet established. This paper reviews past experimental and theoretical models of the geomagnetic tail, outlines present knowledge, and identifies the current major problems associated with its dynamics. (auth)

**30440** AURORAS AND POLAR SUBSTORMS: OBSERVATIONS AND THEORY. Hultqvist, Bengt (Kiruna Geophysical Observatory, Sweden). Rev. Geophys., 7: 129-77(Feb.-May 1969).

From International Symposium on the Physics of the Magnetosphere, Washington, D. C. See CONF-680956.

The results of observations of auroras and polar magnetic substorms are compared with magentospheric models. In general, present qualitative or semi-quantitative magnetospheric models describe fairly well the basic features of auroras and magnetic substorms, or they can probably be adapted to the observations by minor modifications. However, some observations cannot currently be easily interpreted in terms of the models. Of these, the existence of two daytime precipitation zones and some detailed features of the observed particle energy spectrum are among the most important. The stationary models cannot account for the high-energy part of the auroral particle spectrum seen also in quiescent auroras. Some peaks in the observed spectrum also seem to pose problems. On the whole, the quantitative problems of entry and energization of the auroral particles are still unsolved. (auth)

**30441** POLAR AURORAS, POLAR SUBSTORMS, AND THEIR RELATIONSHIPS WITH THE DYNAMICS OF THE MAGNETOSPHERE. Feldshtein, Ya. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Rev. Geophys., 7: 179-218(Feb.-May 1969).

From International Symposium on the Physics of the Magnetosphere, Washington, D. C. See CONF-680956.

Comparison is made between the position of the auroral oval during both night and day and that of the boundaries of trapped radiation according to observations from the satellite Alouette 2. It is shown that visual auroras are located on the poleward side of the boundary of smoothly closed field lines. From the data on auroral dynamics, information is obtained on some parameters of the geomagnetic field, i.e., field intensity in the magnetospheric tail, cross-sectional dimensions of the tail at various geocentric distances, and the length of the tail. The density of low-energy plasma at geocentric distances of 5 to 9 $R_E$ is estimated for various periods of the solar activity cycle. The influence of the magnetospheric ring current on the position of the auroral oval is considered. On the basis of polar auroral observations, estimates are made of variations in ring current parameters at times of ring current enhancement. DP and DPC magnetic field variations at high latitudes, linked with the structure of the geomagnetic field in the magnetosphere, are also discussed. DP variations are characterized by current electrojets, a western one within the auroral oval and an eastern one in the evening hours at $\Phi \sim 65°$, where $\Phi$ is the invariant latitude. The DPC variations of greatest intensity are noted on the daytime side of the Earth. The field variations are due to a counterclockwise current. It is shown that the current system of Chapman's SD variations is a superposition of two different types of variations DP and DPC. (auth)

**30442** MAIN MECHANISMS IN THE FORMATION OF THE EARTH'S RADIATION BELTS. Tverskoi, B. A. (Moscow State Univ.). Rev. Geophys., 7: 219-31(Feb.-May 1969).

From International Symposium on the Physics of the Magnetosphere, Washington, D. C. See CONF-680956.

Present theories relating to the formation of the Earth's radiation belts are reviewed and prospects for future development of these theories are considered. The first part is devoted to the discussion of the possibility of particle injection into the zone of trapped radiation when the drift orbits of particles are perturbed during geomagnetic storms. In the second part it is shown that the experimental data on particle diffusion in the belts are generally in agreement with the concept of sudden impulses. The third is an analysis of the problem of proton and electron leakage due to ionization deceleration and cyclotron instability. (auth)

**30443** CHARGED PARTICLES IN THE MAGNETOSPHERE. Van Allen, James A. (Univ. of Iowa, Iowa City). Rev. Geophys., 7: 233-55(Feb.-May 1969).

From International Symposium on the Physics of the Magnetosphere, Washington, D. C. See CONF-680956.

Observational work by the Univ. of Iowa concerning the dynamics of the population of charged particles in the outer radiation zone of the magnetosphere is reviewed. Topics covered include: (a) intensity fluctuations and apparent lifetimes of outer-zone electrons having kinetic energies ranging from 40 keV to several MeV; (b) ring-current particles, protons and electrons, $E \gtrsim 200$ eV; (c) geomagnetically trapped $\alpha$ particles between 2.09 and 15 MeV; and (d) the electric field in the magnetotail. (W.D.M.)

**30444** PARTICLE FLUXES IN THE OUTER GEOMAGNETIC FIELD. Vernov, S. N.; Gorchakov, E. V.; Kuznetsov, S. N.; Logachev, Yu. I.; Sosnovets, E. N.; Stolpovskii, V. G. (Moscow State Univ.). Rev. Geophys., 7: 257-80(Feb.-May 1969).

From International Symposium on the Physics of the Magnetosphere, Washington, D. C. See CONF-680956.

The outer geomagnetic field comprises the outer radiation belt, consisting of electrons with energies of $10^4$ to $10^7$ eV, and the unstable radiation zone. The outer radiation belt is bounded on its inner side by a gap, which is at various times located at a distance of 2.2 to 3.5 $R_E$ and in which a considerable precipitation of electrons from radiation belts occurs, possibly because of a high intensity of electromagnetic waves. The boundary separating the outer radiation belt from the unstable radiation zone is at $\lambda \sim 71°$ and $\sim 9$ $R_E$ in the equatorial plane on the sunlit side, and at 7 to 8 $R_E$ in the equatorial plane on the nightside. Beyond this, the unstable radiation zone extends out to the magnetosphere boundary and up to $\lambda \sim 77°$ on the sunlit side, and out to 14 to 15 $R_E$ on the nightside. The relatively rapid electron intensity variations with periods of 1 to 7 days are essentially absent at distances less than that of the outer belt but are distinctly seen in the outer belt. In the unstable radiation zone the intensity of electrons with energies of the order of $10^5$ eV changes by several times, and good correlation is observed with the increase in $K_p$. Analysis of the outer belt data shows that this belt is formed partly by electron diffusion into the magnetosphere (like the belt of protons with energies of $10^5$ to $10^7$ eV) and partly by the simultaneous acceleration of electrons at various distances from the Earth. A comparison of electron intensity changes with the solar activity cycle shows little or no correlation for electrons with $E_e > 40$ keV. The intensity of electrons with $E_e > 500$ keV has changed significantly; in 1964 it was 30 times lower than in 1959. The absence of significant dependence of the diffusion coefficients for electrons with $E \sim 10^4$ to $10^5$ eV on the phase of the solar activity cycle shows that the relatively weak magnetic disturbances that do not change with the phase of the cycle are of major importance in diffusion. This suggests that these magnetic disturbances appear at great distances from the Sun because of the instabilities of plasma itself and, therefore, that they depend little on solar activity. (auth)

**30445** LOW-FREQUENCY WAVES IN THE MAGNETOSPHERE. Helliwell, R. A. (Stanford Univ., Calif.). Rev. Geophys., 7: 281-303(Feb.-May 1969).

From International Symposium on the Physics of the Magnetosphere, Washington, D. C. See CONF-680956.

In the magnetosphere are found low-frequency (100 to 100,000 Hz) electromagnetic waves generated externally by lightning and ground-based transmitters and internally by energetic charged particles. Dispersion and anisotropy characterize the medium, and both ducted and nonducted paths of propagation are found. Lightning-generated ducted "whistlers," observed on the ground, give information on the distribution of electrons and the latitudinal drift motions of ducts in the magnetosphere. Nonducted whistlers observed in satellites give information on electron and ion concentrations, the Earth's magnetic field, and wave damping by energetic particles. Noise generated in the magnetosphere (or ionosphere) includes steady noise, or hiss, and the structured forms known as discrete emissions. In the auroral zone, hiss is seen in close association with the aurora and over a frequency range of at least 4 kHz to several hundred kHz. It has been attributed tentatively to incoherent Cherenkov radiation from the incoming auroral particles. At middle latitudes, noise from the magnetosphere is mostly of the discrete type with associated hiss and appears to be limited to frequencies below the minimum gyrofrequency on the path of propagation. A related type of noise, called "polar chorus," appears at high latitudes below about 1500 Hz. Discrete emissions may occur spontaneously or be triggered by whistlers or man-made signals from the ground. The upper cutoff frequency is controlled by the minimum gyrofrequency on the path of propagation, indicating that the region of generation lies in the equatorial plane. Discrete emissions have been attributed to cyclotron resonance between whistler-mode waves and electrons. Emissions offer new possibilities for studying wave-particle interactions in the magnetosphere and in other plasmas, both natural and man-made. (auth)

**30446** PITCH-ANGLE DIFFUSION OF ELECTRONS IN THE MAGNETOSPHERE. Roberts, Charles S. (Bell Telephone Labs., Murray Hill, N. J.). Rev. Geophys., 7: 305-37(Feb.-May 1969).

From International Symposium on the Physics of the Magnetosphere, Washington, D. C. See CONF-680956.

This paper reviews the experimental and theoretical knowledge concerning pitch-angle diffusion of trapped electrons in the Earth's radiation zones. Experimental information bearing on pitch-angle diffusion has been obtained from data on electron flux decay following artificial injection by a nuclear explosion or following natural injection during a period of magnetospheric activity. Useful information has also been obtained by studying the trapped-electron pitch-angle distributions and the precipitation of electrons into the atmosphere at low altitudes. The theory of pitch-angle diffusion based upon the Fokker–Planck equation is discussed, and some simple cases of this theory are worked out. Several different pitch-angle scattering mechanisms that may be important for trapped electrons, such as cyclotron resonance, bounce resonance, and atmospheric Coulomb scattering, are also discussed. (auth)

**30447** LOW-ENERGY PLASMA IN THE EARTH'S MAGNETOSPHERE. Gringauz, K. I. (Radiotechnical Inst., Moscow). Rev. Geophys., 7: 339-78(Feb.-May 1969).

From International Symposium on the Physics of the Magnetosphere, Washington, D. C. See CONF-680956.

The low-energy plasma fluxes in the magnetosphere, with energies from thermal up to ~50 keV, are an important factor in determining many of the essential properties of the magnetosphere. Currents produced by the motion of these charged particles play a key role in the development of magnetic storms and in the production of auroras and the geomagnetic tail. This paper reviews the experimental observations of this plasma obtained over the last decade in different regions of the magnetosphere, considered in order of increasing distance from the Earth. The similarity of results from measurements of the ion and electron components of the Earth's thermal plasma envelope and the dependence of the altitude of the boundary of this envelope (the "plasmapause") on geomagnetic activity are described. Within the radiation belts there exists a low-energy plasma component that is much more variable than the energetic component; the variation of low-energy plasma fluxes in the outer belt seems to be the main cause of geomagnetic storms. The radiation belts are always surrounded by low-energy plasma fluxes; on the night side these fluxes become a part of the thick plasma layer within which is embedded the neutral sheet of the geomagnetic tail. Experimental data on low-energy plasma at geocentric distances >2 $R_E$ and geomagnetic latitudes >45° are very scarce; this region needs intensive investigation. (auth)

**30448** CONSEQUENCES OF A MAGNETOSPHERIC PLASMA. Kennel, Charles F. (Univ. of California, Los Angeles). Rev. Geophys., 7: 379-419(Feb.-May 1969).

From International Symposium on the Physics of the Magnetosphere, Washington, D. C. See CONF-680956.

The hypothesis that, in some cases, instabilities in the magnetospheric plasma create the maximum dissipation available to them is explored. In the case of pitch-angle diffusion instabilities, the tendency toward isotropy on auroral lines of force is evidence for strong pitch-angle diffusion. The location of the auroral precipitation boundary may be computed by balancing convection with strong-diffusion precipitation. The radial diffusion required to balance precipitation losses of energetic protons and electrons in the Van Allen zone could approach the Bohm diffusion rate, probably another maximum dissipation limit, at least for instabilities in the drift scaling. (auth)

**30449** MAGNETOSPHERIC CONVECTION. Axford, W. I. (Univ. of California, San Diego, La Jolla). Rev. Geophys., 7: 421-59(Feb.-May 1969).

From International Symposium on the Physics of the Magnetosphere, Washington, D. C. See CONF-680956.

Magnetospheric convection, which implies the existence of large-scale electric fields, appears to be the dominant process for the acceleration and injection of moderately energetic plasma into the magnetosphere. The aurora, the radiation belts, and the "thermal" plasma beyond the plasmapause are directly controlled by the convection induced by the solar wind. The existence of the plasmapause and its variations with time can be understood in terms of convection, and, even within the plasmapause, the radiation belts and the ionospheric plasma are strongly affected by tidally induced convection and the more random convection associated with DP1 and DP2 geomagnetic activity. The basic features of convection are discussed briefly in this review. Direct and indirect observations that provide evidence for the existence of convection are described, and the expected nature of the solar-wind-induced convection in the outer magnetosphere is discussed at some length. A fairly complete bibliography concerning the theory of magnetospheric convection is provided in the references. (auth)

**30450** INTERNATIONAL SYMPOSIUM ON THE PHYSICS OF THE MAGNETOSPHERE, HELD IN WASHINGTON, D. C., SEPTEMBER 3-13, 1968. MacDonald, Gordon J. F. (ed.). Rev. Geophys., 7: 1-459(Feb.-May 1969). (CONF-680956).

This volume contains all of the fifteen invited review papers

presented at the International Symposium on the Physics of the Magnetosphere. Emphasis was placed upon a re-examination and summary of the past decade's research in magnetospheric physics. Separate abstracts were prepared for the fifteen papers. (W.D.M.)

*For abstracts of individual papers see: 30436–30449, and 30451.*

**30451** SOLAR WIND INTERACTION WITH THE GEOMAGNETIC FIELD. Parker, E. N. (Univ. of Chicago). Rev. Geophys., 7: 3-10(Feb.-May 1969).

From International Symposium on the Physics of the Magnetosphere, Washington, D. C. See CONF-680956.

The interaction of the solar wind with the geomagnetic field is a complicated physical phenomenon. This paper attempts to point out the various major effects involved directly in the interaction and to assess the degree to which the effects are, and are not, understood at the present time. (W.D.M.)

**30452** NEW ANALYSIS FOR THE GEOMAGNETIC $D_{st}$ FIELD OF THE MAGNETIC STORM ON JUNE 18–19, 1936. Anderssen, R. S.; Seneta, E. (Australian National Univ., Canberra). J. Geophys. Res., 74: 2768-73(May 15, 1969).

In re-examining the significance of the data for the storm of June 18–19, 1936, it was found that the estimates for probable errors given by Rikitake and Sato are extremely conservative. For this reason, an outline of a statistical analysis that leads to expressions for estimates of $(e_1 + i_1)$ and $(e_1 - 2i_1)$ and their standard errors is given. These estimates in turn lead to estimates for $e_1$ and $i_1$ together with their standard errors. The results obtained on the basis of the new analysis are compared with the values given by Rikitake and Sato. (auth)

## Low-Temperature Physics

*Refer also to abstracts 29075–29077, 29193, 29271, 29276–29281, 30295, 30296, 30638, 30640, 30895, and 31196.*

**30453** (N-69-15382) SUPERCONDUCTIVE MAGNET SYSTEM, 14-TESLA, 15-cm-BORE. Schrader, E. R.; Thompson, P. A. (Radio Corp. of America, Harrison, N. J.). Jan. 1969. Contract NAS3-7101. 55p. (NASA-CR-1260). CFSTI.

A description is presented of the design and construction of a 14-tesla (140 kG) electromagnet with a 15-cm bore and using $Nb_3Sn$ ribbon. A support system was developed in parallel with magnet design and construction. This system contains a standing research helium dewar and commercially available power supplies. A control console and interconnecting cables complete the entire magnet system. The magnet has four electrically separated groups of windings, the power to which can be supplied and controlled individually. This arrangement provides for a wide range of sequential and synchronized control of the electrical modules. Such control is necessary when optimum powering of the magnet is obtained and field produced by the electromagnet is maximized. (auth)

**30454** (NP-17882) DYNAMICAL SCALING LAWS AND TIME DEPENDENT GINZBURG–LANDAU EQUATION. Note No. 209. di Castro, C.; Ferro-Luzzi, F.; Tyson, J. A. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). Mar. 11, 1969. 7p. Dep.

It is shown that a self-consistent version of the time-dependent Ginzburg–Landau theory yields results in agreement with dynamical scaling. (auth)

**30455** SPECTRAL PROPERTIES OF WEAKLY COUPLED SUPERCONDUCTORS. Dmitrenko, I. M. (Kharkov Inst. of Low Temperatures Physics and Tech.). Ukr. Fiz. Zh., 14: 439-47(Mar. 1969). (In Russian).

The available experimental data concerning the spectra of current steps on volt–ampere characteristics and emission spectra of different types of weak superconducting contacts are considered. The observable spectral singularities of different contacts are shown to admit a single qualitative interpretation in terms of unharmonicity of superconducting current in time. At the same time, microscopic mechanisms of resistivity must be different in principle for different types of weak contacts. (auth)

**30456** LANDAU-LEVEL WIDTHS, EFFECTIVE MASSES, AND MAGNETIC-INTERACTION EFFECTS IN LEAD. Phillips, R. A.; Gold, A. V. (Ames Lab., Iowa). Phys. Rev., 178: 932-48(Feb. 15, 1969).

The amplitudes of the de Haas–van Alphen effect in lead have been studied in detail using large impulsive magnetic fields and employing a narrow-band filtering system. Crystals of high purity were grown, cut, and mounted in a manner which was essentially strain-free, and the Dingle broadening temperatures $T_D$ for many of these crystals were found to be less than 0.1°K, corresponding to Landau-level widths of less than 1% of the level spacing $\hbar\omega_c$ in a field of about $10^5$ G. These findings strongly suggest that the large level widths ($T_D \approx 1-2$°K) frequently reported in the past for many pure metals arise from destruction of phase coherence by dislocations. Accurate effective mass values have been determined for the extremal orbits at symmetry directions, and these results are compared with the data obtained directly from cyclotron resonance. The temperature dependences of the amplitudes for the harmonic and combination tones provide yet further detailed evidence for the correctness of Shoenberg's proposal that the Lifshitz–Kosevich theory must be modified when the magnetic interaction between conduction electrons is important. The absolute amplitudes of the fundamental oscillations are compared with the theoretical predictions, and the harmonic content is also discussed. (auth)

**30457** EXPERIMENTATION WITH AND PRODUCTION OF SADDLE-SHAPED SUPERCONDUCTING MAGNET FOR 1kW MHD GENERATOR. Todoriki, Itaru; Koyama, Ken-ichi; Matsumura, Akira; Matsuda, Yoshio; Hitotsuyanagi, Hajime; Tada, Koji; Murayama, Tadao. Sumitomo Elec. Tech. Rev., No. 12, 65-73(Mar. 1969).

Considering the magnetic distribution, the supporting method of the magnetic force, the cooling method and the construction method, the magnet was designed and produced with an inner diameter of 290 mm, an outer diameter of 760 mm, and a height of 910 mm. The weight of the whole magnet was 1.2 tons. During the experiment with its operation, a central magnetic field of 23 kG was generated at the exciting current of 460 A. The magnet was also shown to be thoroughly stabilized. (auth)

**30458** ACTION OF DISLOCATIONS ON PINNING IN A SUPERCONDUCTING SINGLE CRYSTAL. Andronikashvili, E. L. (Inst. of Physics, Tbilisi, USSR); Chigvinadze, Dzh. G.; Tsakadze, Dzh. S.; Kerr, R. M.; Lowell, J.; Mendelssohn, K. Phys. Lett., 28A: 713-14(Feb. 24, 1969).

The influence of dislocations on the pinning of Abrikosov's flux lines in a 70 Ta–30 Nb single crystal was studied. It turned out that at small deformations ($\Delta l/l = 4\%$), when compared with a nondeformed crystal, the coupling energy of the flux lines with the lattice imperfections increases, while at large deformations ($\Delta l/l = 42\%$) the pinning vanishes completely within the accuracy provided by the equipment. (auth)

**30459** ORDER-PARAMETER FLUCTUATIONS AND THE ONSET OF SUPERFLUIDITY IN THIN $^4$He FILMS. Revzen, M. (Univ. of California, Los Angeles). Phys. Rev. Lett., 22: 1102-4(May 26, 1969).

A new method for calculating the resistance of superfluids is proposed. The method is applied to derive the temperature-dependent thickness of $^4$He films at which superflow ceases. The agreement with the experimental results is good. (auth)

**30460** BULK EFFECTS IN SUPERFLUID HELIUM. II. STUDY BY A FUNCTIONAL METHOD. Maki, K. (Tohoku Univ., Sendai); Guyon, E. J. Phys. (Paris), 30: 63-70(Jan. 1969). (In French).

A model of the critical behavior of the superfluid phase of helium is presented that is consistent with the general idea of the phase transition of Landau. The model explains the logarithmic singularity of the bulk helium at the lambda point which is not obtained in the original theory of Ginzburg and Pitaevskii. Here the fluctuations of the order parameter play a dominant role in the properties of the system. In the framework of this model the superfluid density calculations are in good agreement with recent experimental results. Making a simple assumption on the geometrical configuration, the critical properties of helium due to size effects are discussed: shift in the transition temperature $T_\theta$ and specific heat and superfluid density near $T_\theta$. (auth)

**30461** SUPERCONDUCTORS AND SUPERFLUIDS. Bardeen, John (Univ. of Illinois, Urbana). Proc. Robert A. Welch Found. Conf. Chem. Res., 11: 167-83(1968).

From 11th Robert A. Welch Foundation Conference on Chemical Research, Radiation, and the Structure of Matter, Houston, Tex. See CONF-671219.

Theory and experiments on superfluid flow in liquid helium below the $\lambda$ transition and on supercurrent flow of electrons in superconductors are reviewed. Both systems exhibit quantum phenomena on a macroscopic scale. Examples are quantization of circulation and of flux and quantum interference effects in Josephson junctions. (auth)

**30462** ANOMALOUS GREEN FUNCTIONS FOR LIQUID $^4$He. Fritzsch, K. (Institut fuer Optik und Spektroskopie, Berlin). Ann. Phys. (Leipzig), 21: 70-9(1968). (In German).

In condensed systems of many particles, abnormal Green functions are observed, as for example the three-halves function arising from three production or annihilation operators. Statements on three-halves functions with exterior phonon lines, which were previously made valid with phenomenological arguments, were microscopically proven. In the self-energy part, the abnormal contributions lead to singularities which can be eliminated collectively. In the decay region this succeeds by the assumption of a complex excitation energy. (tr-auth)

**30463** COMMUTATORS IN QUANTUM HYDRODYNAMICS FOR INTERACTING BOSE SYSTEMS. Fanelli, Robert; Struzynski, R. E. (City Univ., Brooklyn). Phys. Rev., 182: 363-4 (June 5, 1969).

It is shown that the curl of the velocity operator in the second quantized version of quantum hydrodynamics for interacting Bose systems is equal to zero, thus resolving the apparent discrepancies between various existing formulations. (auth)

**30464** THERMODYNAMICS OF THE ISENTROPIC SOUND VELOCITY NEAR THE SUPERFLUID TRANSITION IN $^4$He. Ahlers, Guenter (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 182: 352-62(June 5, 1969).

A thermodynamic relation between the isentropic velocity of sound u in the zero frequency limit and the heat capacity for $^4$He near the superfluid transition temperature $T_\lambda$ is presented. The validity of the calculation depends upon the logarithmic temperature dependence of the heat capacity. The effect of the gravitational field on u in samples of finite height is calculated. The minimum measurable velocity in real samples exceeds the velocity at $T_\lambda$ by at least 48 cm/sec. The major contribution to the velocity arises from a term whose temperature dependence is $C_p^{-1}$. However, there are additional appreciable contributions whose temperature dependence is $T_\lambda - T$ and $(T_\lambda - T)\ \ln|T_\lambda - T|$. Comparison with the measurements of Barmatz and Rudnick shows that the present treatment quantitatively explains all the features of the experimental data. The calculation can be used to determine the contribution from dispersion to measured velocities at nonzero frequencies. (auth)

**30465** SCALING OF THE SPECIFIC-HEAT SINGULARITY OF $^4$He NEAR ITS CRITICAL POINT. Moldover, M. R. (Univ. of Minnesota, Minneapolis). Phys. Rev., 182: 342-52(June 5, 1969).

The specific heat was measured at constant volume ($C_v$) of $^4$He near its critical temperature ($T_c$) and critical density ($\rho_c$). Tabulated data are given along seven isochores with densities in the range $-0.10 < \Delta\rho < +0.15$, where $\Delta\rho = (\rho - \rho_c)/\rho_c$, at temperatures in the range $-0.06 < t < +0.13$, where $t = (T - T_c)/T_c$. Density resolution was $0.001\ \rho_c$ and the resolution of $C_v$ measurements was $0.0003T_c$ in temperature. Resulting values for the critical constants are $T_c = 5.1891 \pm 0.0007$ K and $\rho_c = 0.06958 \pm 0.00007$ g/cm$^3$. The data in the one-phase region may be expressed as the sum of a nonsingular function of t and $\Delta\rho$ and a function of the form $|\Delta\rho|^{-\alpha/\beta} f(x)$, where $\alpha$ is the exponent describing the singularity in $C_v$ at density $\rho_c$ in the one-phase region, $\beta$ is the exponent describing the coexistence curve, and x is the variable suggested in Griffith's discussion of homogeneous functions, $t|\Delta\rho|^{-1/\beta}$. In the two-phase region $C_v$ diverges with an exponent $\alpha'$ with $\alpha' \approx \alpha \approx 0.15$. In the two-phase region the singularity in $C_v$ seems to be dominated by $d^2P/dT^2$ where P is the vapor pressure. If $\mu$ is the chemical potential $d^2\mu/dT^2$ is less singular than $d^2P/dT^2$ and may even be constant in this temperature range. The singularity in $d^2P/dT^2$ implies the $T_{58}$ helium vapor-pressure temperature scale is slightly in error. If $T_{58}$ and its first derivative are assumed correct at 4.85°K, then $T_{58}$ assigns a temperature 0.0007 K too high to pressures near the critical pressure. Where the $C_v$ data may be compared to P−V−T data on $^4$He the agreement is generally good. The possibility now exists of making a complete model of the free energy near the critical point. (auth)

**30466** QUANTUM LIQUIDS. II. MICROSCOPIC THEORY OF LIQUID $^3$He–$^4$He MIXTURES. McMillan, W. L. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 182: 299-306(June 5, 1969).

The equilibrium and transport properties of the mixtures are calculated, using the overcomplete basis functions $\varphi_{\vec{k}}\psi_{\vec{q}}$ discussed in Part I. The theory includes the enlarged correlation hole of a single $^3$He and the backflow of $^4$He atoms around it. The two-quasi-particle scattering amplitude is the sum of two terms

$$V = -\alpha^2 \frac{m_4 s^2}{n} - \frac{\hbar^2(\vec{k}\cdot\vec{q})\ (\vec{k}'\cdot\vec{q})}{m_4 n q^2}\left(\frac{(1+\alpha)m_4 + \delta m}{m_3 + \delta m}\right)^2$$

the first from the interaction of the excess correlation holes and the second from the interaction of the backflows. Both terms were derived previously from macroscopic considerations by Bardeen, Baym, and Pines. (auth)

**30467** CONDENSATION IN A TWO-DIMENSIONAL HARTREE–FOCK BOSON GAS. Grobman, Warren D. (Bellcomm, Inc., Washington, D. C.). Phys. Rev., 182: 297-9(June 5, 1969).

The behavior of a two-dimensional gas of interacting bosons is studied in the Hartree−Fock approximation in the low-temperature strong-interaction regime. It is shown that the thermodynamic state of lowest free energy possesses a Bose−Einstein condensation. The fact that the occurrence of long-range order in this two-dimensional system is a consequence of the nonlocality of the Hartree−Fock interaction is discussed. (auth)

**30468** EQUILIBRIUM FLUCTUATIONS AND STABILITY OF THE CONDENSATE OF A DEGENERATE BOSON FLUID. Glassgold, A. E.; Sauermann, H. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Phys. Rev., 182: 262-80 (June 5, 1969).

A general theory is formulated for the fluctuations in the condensate of a degenerate boson fluid in homogeneous thermodynamic equilibrium. The point of view adopted is based on Bogolyubov's description of the condensate in terms of quasi averages and on his "Principle of Diminishing Correlation." An essential aspect of the theory is the consistent treatment of the fluctuation operators c and c†, where $c = a_0 - \alpha$, $a_0$ is the annihilation operator for the zero momentum state, and the order parameter $\alpha$ is the quasi average of $a_0$. After the Hamiltonian for the fluctuation operators is obtained, a stability condition is derived, which is then shown to be satisfied under very general conditions. The energy spectrum of the condensate fluctuations is shown to be discrete, and explicit expressions are derived for the quantum states of the condensate. The ground state of the condensate is not a coherent state of the type studied by Glauber. A detailed analysis is given of the fluctuations in the order parameter and in the number of particles in the condensate. The physical properties of the fluctuations are determined by two parameters, which are the averages of the second derivatives of the Hamiltonian with respect to the order parameter. These quantities are shown to be related to the one-particle Green's functions introduced by Belyaev. The implications of this general theory are also worked out for Bogolyubov's low-density, weak-coupling model. The limit of the ideal Bose gas is then shown to possess pathological features, namely an unnormalizable ground state and infinite fluctuations, in contrast to the interacting fluid where all properties are well-behaved. (auth)

**30469** ION MOTION AND VORTEX-RING FORMATION IN PURE LIQUID $^4$He AND $^3$He–$^4$He SOLUTIONS BETWEEN 0.05 AND 0.5 K. Neeper, D. A.; Meyer, Lothar (Univ. of Chicago). Phys. Rev., 182: 223-34(June 5, 1969).

Measurements of the behavior of charge carriers produced by $\alpha$ particles in pure liquid $^4$He and in $^3$He−$^4$He solutions in the temperature range 0.05 to 0.5°K are reported. Attempts to study very small vortex rings with less than 0.1-eV energy were not successful due to stray electrostatic fields. The origin of these fields was investigated in detail. Above 0.36°K negative ions under pressure in pure $^4$He can be accelerated to the Landau velocity for roton production, but it was found that they produce only vortex rings at lower temperatures. The mobilities of both positive and negative ions in $^3$He−$^4$He solutions show temperature dependences in disagreement with all previously proposed theories; however, the negative-ion mobility increases sharply below T = 0.1°K in a fashion similar to the predicted phonon-limited mobility. The scattering per $^3$He atom is not a simple function of $^3$He concentration and does not show any appreciable change as the solution varies from a dilute to a mildly degenerate Fermi system. At 0.2°K the pressure dependence of the negative-ion mobility is consistent with the change of bubble radius derived from other experiments, but at 0.08°K it is different. (auth)

**30470** ADDENDUM TO "THEORY OF A $^3$He ATOM IN LIQUID $^4$He AT T = 0." Davison, T. B.; Feenberg, E. (Washington Univ., St. Louis). Phys. Rev., 182: 364-5(June 5, 1969).

An improved estimate of the interaction matrix element $\langle\vec{k},\vec{k}'|H - \langle\vec{k}|H|\vec{k}\rangle\ |\vec{k}\rangle$ is generated by a new approximation for the three-particle distribution function. Revised numerical results are presented for binding energy, effective mass, and differential volume coefficient of the $^3$He atom in solution. (auth)

**30471** PHASE TRANSITIONS IN FERMI SYSTEMS. Johansson, Boerje. Stockholm, Univ. of Stockholm, 1969. 10p. Thesis.

A summary is made of 9 published papers by the author and co-authors on the following subjects: breaking average and field theoretical method in superconductivity; quantum field theory of phase transitions in Fermi systems; a field theoretical description of states with different orbitals for different spins, paramagnetic susceptibility and stability of the electron gas in a modified Hartree−Fock approximation; a possible generalized instability criterion applied to the one-dimensional delta-function interacting

Fermi gas; calculation of the instability against "different orbitals for different spins" for a uniform fermion gas with a repulsive delta-function interaction; the meaning of unstable spin-wave modes; dirt in Slater's split-band model of antiferromagnetism; and itinerant antiferromagnetism in a infinite linear chain. (Sweden)

**30472** SPIN FLUCTUATIONS AND SUPERCONDUCTIVITY: VARIATIONAL CALCULATION OF THE TRANSITION TEMPERATURE. Morandi, G. (Imperial Coll. of Science and Tech., London). Phys. Lett., 29A: 212-13(May 5, 1969).

An asymptotically exact analytical formula for the superconducting transition temperature is derived by making use of a variational principle for the gap equation. (auth)

**30473** INCREASE OF SUPERCONDUCTING TRANSITION TEMPERATURES. Matthias, B. T. (Univ. of California, San Diego, La Jolla, Bell Telephone Labs., Murray Hill, N. J.). Phys. Bull., 20: 188-9(May 1969).

The quest for higher (and lower) transition temperatures in the domain of superconductivity is discussed. It is stated that the highest reported transition temperature is at 21°K for the compound $Nb_3(Al_{0.75}Ge_{0.25})$ while the lowest is $\sim 10^{-2}$ °K for tungsten. The temperature range at present exceeds a factor of $10^3$, but it is not clear how to proceed further. Difficulties lie in the intrinsic nature of co-operative phenomena. Transition temperatures still cannot be calculated from first principles. Approaches made to understand, predict and raise superconducting transition temperatures are reviewed, with regard to the transition and nontransition elements. A fresh theoretical approach is advocated. (UK)

**30474** CRITICAL CURRENTS IN SUPERFLUID HELIUM NEAR $T_\lambda$. Leiderer, P.; Pobell, F. (Technische Hochschule, Munich). Z. Phys., 223: 378-84(1969).

The temperature dependence of the critical heat current $Q_c$ in He II was measured in the temperature region $3 \cdot 10^{-6}$ (°K) < $T_\lambda - T < 1.2 \cdot 10^{-2}$ (°K). The result $Q_c \propto (T_\lambda - T)^{1.07 \pm 0.01}$ is consistent with a divergent mutual friction near $T_\lambda$ proposed recently by Ahlers. (auth)

**30475** THE INFLUENCE OF $\omega$ PHASE ON THE SUPERCONDUCTIVITY OF Ti–Mo ALLOYS. Ho, J. C.; Collings, E. W. (Battelle Memorial Inst., Columbus, Ohio). Phys. Lett., 29A: 206-7(May 5, 1969).

In Ti–Mo alloys the maxima in the low-temperature electronic specific heat coefficient ($\gamma$) and the superconducting transition temperature ($T_c$) which occur near 20 at.% Mo ($e/a \sim 4.4$) are induced by omega-phase precipitates in the lower concentration alloys, which decrease $\gamma$ and $T_c$ below the values expected for an unperturbed bcc lattice. (auth)

**30476** RADIATION FROM MOVING VORTICES IN SUPERCONDUCTORS. Meincke, P. P. M. (Univ. of Toronto). Phys. Lett., 29A: 208-9(May 5, 1969).

It is pointed out that the fluctuating currents due to moving vortices in a type-II superconductor should not give rise to electromagnetic radiation except when the phase velocity of the current structure can be closely coupled to that of the radiation. (auth)

**30477** RESISTIVE TRANSITION IN WEAKLY COUPLED SUPERCONDUCTORS. Thompson, R. S.; Strongin, M.; Krammerer, O. F.; Crow, J. E. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett., 29A: 194-5(May 5, 1969).

Films of weakly connected particles have narrower transitions above the half-resistance point than uniform films of the same resistance. In contrast, the region of finite resistivity below the halfway point remains very broad. (auth)

**30478** SCALING BEHAVIOR IN THE MICROSCOPIC APPROACH TO THE THEORY OF SUPERFLUID HELIUM. De Pasquale, F. (Istituto di Fisica, Rome. Gruppo Nazionale Struttura della Materia, Rome); Tabet, E. Phys. Lett., 29A: 197-8(May 5, 1969).

The behavior near $T_\lambda$ of the superfluid density $\rho_s(k,T)$ is investigated in the framework of a microscopic theory. (auth)

**30479** ATTENUATION OF MICROWAVE PHONONS IN THE MIXED STATE OF NIOBIUM. Buisson, R. (Faculte des Sciences, Grenoble, France. Societe Alcatel, Paris); Cheeke, J. D. N. Phys. Lett., 29A: 200-1(May 5, 1969).

Absorption of 10-GHz longitudinal hypersonic waves is reported near $H_{c1}$ in pure Nb at 1.3°K. Anomalies were observed for applied field parallel to the propagation direction. (auth)

**30480** POSITRON ANNIHILATION IN SUPERCONDUCTIVE NIOBIUM–ALUMINIUM ALLOYS. Dekhtjar, I. J.; Mikhalenkov, V. S.; Sakharova, S. G. (Inst. of the Physics of Metals, Kiev). Phys. Lett., 29A: 148-9(Apr. 21, 1969).

The angular correlation of positron annihilation radiation was studied in the superconductive Nb–Al alloys. From the results of the work the estimation of parameters of the equation for the critical temperature of superconductive transition was made. (auth)

**30481** EXTRACTION OF ELECTRONS FROM QUANTIZED VORTEX LINES. Schoepe, W.; Dransfeld, K. (Technische Hochschule, Munich). Phys. Lett., 29A: 165-6(May 5, 1969).

If electrons are trapped in vortex lines of rotating He II, they can emerge into the vapor phase without overcoming any detectable energy barrier. This observation of the extraction of electrons from straight vortex lines above 1.1°K agrees very well with the evaporation of electrons from vortex rings studied by Surko and Reif below 0.7°K. (auth)

**30482** STUDY OF INTERACTING BOSE GAS WITH CURRENTS AND DENSITIES AS COORDINATES. Vasudevan, R.; Sridhar, R.; Ranganathan, N. R. (Inst. of Mathematical Sciences, Madras). Phys. Lett., 29A: 138-9(Apr. 21, 1969).

Using currents and densities as coordinates for the description of the Hamiltonian of an interacting boson system and also for the excitation operator, the low-momentum excitation spectrum is developed by the equation of motion method under the random phase approximation. (auth)

**30483** LARGE ANOMALY OF THE DIAMAGNETIC SUSCEPTIBILITY ABOVE THE SUPERCONDUCTING TRANSITION TEMPERATURE. Yamaji, K. (Tokyo Univ.). Phys. Lett., 29A: 123-4(Apr. 21, 1969).

The possibility of observing a surprisingly large anomaly in the diamagnetic susceptibility in the temperatures slightly above the superconducting transition temperature is pointed out. It is due to the fluctuation of the order parameter and given by $0.84\{T_c \chi(\rho)/(T-T_c)\}^{\frac{1}{2}} \chi_L$ for the bulk sample. (auth)

**30484** SUPERCONDUCTIVITY OF COMPOUNDS HAVING THE $Si_2U_3$-TYPE STRUCTURE. Havinga, E. E.; Van Maaren, M. H.; Damsma, H. (Philips Research Labs., Eindhoven, Netherlands). Phys. Lett., 29A: 109-10(Apr. 21, 1969).

Three compounds out of thirteen having the $Si_2U_3$-type structure were found to become superconducting above 0.1°K, viz., $Be_2Nb_3$, $Be_2Ta_3$ and $Al_2Th_3$ at 2.3, 1.0 and 2.6°K, respectively. Another new superconductor reported is $Ga_2Nb_3$ with $T_c = 1.35$°K. (auth)

**30485** SUPERCONDUCTING CRITICAL FIELDS AND CURRENTS OF Nb–Ti–N THIN FILMS IN CONTINUOUS MAGNETIC FIELDS TO 175 kG. Zbasnik, Jon (Univ. of Minnesota, Minneapolis); Toth, Louis E.; Shy, Y. M.; Maxwell, E. J. Appl. Phys., 40: 2147-52(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Superconducting critical current-field measurements were made on a series of Nb–Ti–N thin film alloys (1000–8000 Å) prepared by reactive sputtering. Samples were measured in dc transverse and parallel fields. A pronounced maximum in the critical field occurs at approximately 20 mole % TiN. The extrapolated zero current value of $H_{c2}$ for this composition at 4.2°K was greater than 180 kG. Critical current densities in parallel fields are comparable to those of other high-field bulk superconductors ($10^4$ A/cm² at 150 kG). Films 2000 Å thick and 0.1 in. wide carried a few tenths of an ampere in fields as high as 120 kG in the transverse fields and as high as 140 kG in parallel fields. In the transverse orientation the critical current density appears to be independent of thickness. Possible application of these materials to miniature thin-film solenoids is discussed. (auth)

**30486** HIGH FIELD PROPERTIES OF PURE NIOBIUM NITRIDE THIN FILMS. Deis, D. W.; Gavaler, J. R.; Hulm, J. K.; Jones, C. K. (Westinghouse Research Labs., Pittsburgh). J. Appl. Phys., 40: 2153-6(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Thin films of the rocksalt structure (B1) compounds of the transition metals can be prepared by the method of reactive sputtering. By a refinement of this technique, thin films of niobium nitride (NbN) were produced, for the first time, with transition temperatures similar to those of the bulk materials ($\gtrsim$15°K). Films have been prepared on both hastelloy and fused silica substrates. Measurements of the normal state resistivity $\rho_n$ yield values in excess of 200 $\mu\Omega \cdot$ cm. Preliminary studies of the resistive transitions in these materials near $T_c$ indicate that $H_t(J)$, the field at which $\rho/\rho_n = \frac{1}{2}$, is independent of current density below 200 A/cm² for films 1000 to 4000 Å thick. Identifying $H_t(J)$ ($J < 50$ A/cm²) with the upper critical field $H_{c2}(t)$, the measurements indicate that $H_{c2}(0)$ is significantly in excess of 200 kOe, and thus is substantially higher than the values obtained for the bulk material. These results are discussed in terms of the current theories of high field superconductivity with particu-

lar reference to the importance of Pauli spin paramagnetism and spin–orbit scattering in these materials. (auth)

**30487** MICROWAVE CONDUCTIVITY OF GRANULAR SUPERCONDUCTING ALUMINUM FILMS. D'Aiello, R. V. (RCA Labs., Princeton, N. J.); Freedman, S. J. J. Appl. Phys., 40: 2156-60(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Measurements of the transmission amplitude and phase of 20-GHz microwaves through superconducting granular aluminum films were made as a function of temperature from 4.2 to 1.75°K. The films were fabricated by vacuum deposition in the presence of controlled amounts of oxygen, and exhibited small grain size (~40 Å) and enhanced transition temperatures of up to 2.86°K. The temperature coefficients of resistance (TCR) for the films ranged from slightly positive to almost zero, and for several films the TCR was negative. For all films measured, the microwave transmission data agreed very well with that computed by using the Mattis and Bardeen conductivity functions. (auth)

**30488** PRINCETON FLOATING MULTIPOLE-SUPERCONDUCTING RING PROGRESS. File, J.; Martin, G. D.; Mills, R. G.; Upham, J. L. (Princeton Univ., N. J.). J. Appl. Phys., 40: 2106-8(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Two independent concentric $Nb_3Sn$ rings carrying persistent supercurrents were successfully levitated and stabilized against the slide instability. Isochoric Dewar operation was demonstrated with the ring stabilized against both the slide and flip modes. The optical position sensors were improved. (auth)

**30489** THIN-FILM JOSEPHSON JUNCTIONS USING GETTER-SPUTTERED NIOBIUM. Nordman, J. E. (RCA Labs., Princeton, N. J.). J. Appl. Phys., 40: 2111-15(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Thin-film niobium/niobium oxide/lead Josephson junctions were fabricated by use of getter sputtering for the Nb films, thermal oxidation of the Nb and evaporation of the Pb top films. These devices have characteristics comparable to good Pb/PbO/Pb devices. Temperature cycling is not harmful to the devices although some drift with time is seen in the characteristics. This drift is in the form of a conductance increase which has been measured as something between a factor of 1.1 to a factor of 20 over a period of months with the devices stored at room temperature. (auth)

**30490** FABRICATION OF TUNNEL JUNCTIONS ON NIOBIUM FILMS. Mullen, L. O.; Sullivan, D. B. (NBS-Inst. for Basic Standards, Boulder, Colo.). J. Appl. Phys., 40: 2115-17 (Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

High background currents, often observed in tunnel junctions when the barrier is formed by oxidizing niobium, probably stem from the fact that one oxide of niobium (NbO) is not an insulator. The fabrication process described here uses an active layer of gas adsorbed on the niobium surface that reacts with the upper film (e.g., lead) and forms the junction barrier. This technique avoids the problem above and results in tunnel junctions with low background currents. (auth)

**30491** MAXIMUM TUNNELING SUPERCURRENTS THROUGH JOSEPHSON BARRIERS. Schroen, Walter; Pritchard, J. Paul Jr. (Texas Instruments Inc., Dallas). J. Appl. Phys., 40: 2118-22 (Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

The maximum tunneling supercurrent through Josephson barriers as a function of barrier dimensions and external magnetic fields was investigated experimentally. A versatile sample preparation technique allows a two-dimensional distribution of the tunneling current. The results confirm earlier theoretical predictions qualitatively. At zero applied field the maximum tunneling supercurrent initially increases linearly with the barrier length, then saturates due to self-limiting. At nonzero applied field the maximum tunneling supercurrent decreases linearly with increasing magnetic field. It is shown that this holds also for structures in which the field is generated by crossed-film control supercurrents. The Josephson penetration depth of the samples has been 9 to 22 $\mu$m. (auth)

**30492** BARRIER-THICKNESS DEPENDENCE OF THE DC QUANTUM INTERFERENCE EFFECT IN THIN-FILM LEAD JOSEPHSON JUNCTIONS. Schwidtal, Klaus; Finnegan, Robert D. (Army Electronics Command, Fort Monmouth, N. J.). J. Appl. Phys., 40: 2123-7(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

The barrier-layer thickness of cross-type square Pb/PbO/Pb thin-film Josephson junctions was varied systematically and reproducibly by employing a mask-substrate changer and a low-pressure glow-discharge oxidation technique. A series of junctions has been fabricated in which the ratio of film width w to the Josephson penetration depth $\lambda_J$ is varied from $\lambda_J \gg w$ to $\lambda_J \ll w$ while the width of both films is kept constant at 0.3 mm. The magnetic-field dependence of the maximum zero-voltage current in these junctions has been measured as a function of the barrier-layer thickness. For non-negligible self-fields the tunneling currents, the field dependence follows a Fresnel diffraction pattern rather than a Fraunhofer diffraction pattern. For very thin barrier layers, the maximum zero-voltage current is eventually limited by the critical current of the Pb films. Relatively thick barrier layers, on the other hand, tend to be shorted at the edges, as can be seen from the magnetic-field dependence. The stability of Pb/PbO/Pb Josephson junctions is compared with that of Nb/$NbO_x$/Pb Josephson junctions. (auth)

**30493** AC ENERGY LOSSES ABOVE AND BELOW $H_{c1}$ IN NIOBIUM AND NIOBIUM–25 AT. PERCENT ZIRCONIUM. Beall, W. T. Jr.; Meyerhoff, R. W. (Union Carbide Corp., Indianapolis). J. Appl. Phys., 40: 2052-9(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Calorimetrically determined energy losses for a series of niobium and niobium–25 at.% zirconium samples carrying an af transport current agreed with those calculated from hysteresis loops determined by dc magnetization measurements. The results of this study showed that the energy losses in ultra-high-purity annealed Nb are less than those for any of the other samples studied at magnetic fields less than 1500 G. The magnetic field dependence of the energy losses in all of the samples studied is given by $EL = E_{ff}h^m$, where EL is the energy dissipated per unit surface area per cycle and is independent of frequency, $E_{ff}$ is a constant which depends on the material and surface finish, and $h = H_p/H_{c1}$, where $H_p$ is the peak ac field amplitude, and $H_{c1}$ is the lower critical magnetic field; $m = n_1$ when $h \leq 1$, and $m = n_2$ when $h \geq 1$. For both highly reversible and highly irreversible samples, $n_1 \approx 3$. For the least reversible samples, $n_2 \approx 4$, increasing to ~8 for the most reversible samples studied. $E_{ff}$ generally increased with decreasing reversibility and was strongly dependent on the surface finish of the sample, increasing as the surface roughness increased. The power loss PL per unit surface area is given by $PL = (EL)f$. This linear frequency dependence is consistent with a hysteretic loss mechanism as is the agreement between the calorimetrically determined losses and those calculated from the measured hysteresis loops. (auth)

**30494** STEADY-STATE PERFORMANCE OF MULTISTRAND SUPERCONDUCTING COMPOUND CONDUCTORS. Gauster, W. F. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 40: 2060-5(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

A careful numerical analysis of a measured steady-state I–V (current–voltage) characteristic of a superconducting compound conductor with very fine strands is reported. The actual, nonlinear heat transfer from copper to the helium bath is considered. It is shown that in the current-sharing state the flux flow resistance of the superconductor, $R_f$, increases from zero to values much greater than the copper resistance, $R_{Cu}$. For $R_f \sim R_{Cu}$, the superconductor current $I_s$ is a function of the field H, the voltage V, and the temperature T. For $R_f \gg R_{Cu}$, $I_s$ is a function of H, independent of V, and a linear function of T. The value of this function extrapolated to the bath temperature $T_b$ is appreciably greater than the critical current. In the absence of flux jumps, the current-sharing state should be terminated by the steady-state condition $dI/dV = 0$. The actual "take off" (sudden transition into the normal state) observed, however, took place below the mentioned steady-state limit and before the transition from nucleate to film boiling. The new findings on the steady-state performance of compound conductors with very thin strands make essential modifications of the usual theoretical approaches necessary. It is shown how the new approach can be applied to compound conductors with thick filaments. (auth)

**30495** STEADY-STATE FLUX JUMPING IN SUPERCONDUCTING NIOBIUM–TITANIUM TUBES IN SUPERIMPOSED AC AND DC MAGNETIC FIELDS. Gandolfo, David A. (RCA Advanced Tech. Labs., Camden, N. J.); Dubeck, Leroy; Rothwarf, Frederick. J. Appl. Phys., 40: 2066-70(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Steady-state flux jumping has been observed for a thin-walled tubular sample of Nb–Ti subjected to coaxial superimposed ac and dc magnetic fields. By steady state is meant flux jumping which occurs reproducibly each cycle. The magnitude $\Delta h$ of the field shielded by a sample in the critical state decreases with increasing field rate. A rate-dependent effective resistivity $\rho_{eff}$ that exists just prior to a given flux jump has been calculated from $\Delta h$ and the field rate. It is found that $\rho_{eff}$ increases nonlinearly to a value of about $5 \times 10^{-9}$ Ω·cm at $\dot{h} = 7 \times 10^{5}$ Oe/sec in a background field of 10 kOe. Such a $\rho_{eff}$ is characteristic of the flux-creep state. (auth)

**30496** THEORY OF ELECTRICAL AND THERMAL STABILITY OF A SUPERCONDUCTOR IN THE RESISTIVE STATE. El Bindari, A. (Avco Everett Research Lab., Everett, Mass.). J. Appl. Phys., 40: 2070-5(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

The problem of electrical and thermal stability of a superconductor when carrying a steady-state transport current beyond the critical current has been analyzed for a bare superconductor. The following relation is derived $v = I(I-1)/1-\theta I^2$, where v is the nondimensional voltage, I is the current in units of the critical current, $I_c$, of the superconductor, and $\theta$ is a parameter involving only the constants of the superconductor, and the heat transfer coefficient of the cooling medium. To have a reversible voltage current characteristic beyond the critical current, the parameter $\theta$ should be $\ll 1$. Factors affecting this parameter are analyzed. The influence of this parameter on the propagation of a resistive front is discussed. Furthermore, the influence of a normal metal in good electrical and thermal contact with the superconductor is also included. (auth)

**30497** COMPARISON BETWEEN MEASURED CRITICAL CURRENTS AND A MODEL OF TRANSIENTLY STABILIZED $Nb_3Sn$ MAGNETS. Schrader, E. R. (RCA Electronic Components, Harrison, N. J.). J. Appl. Phys., 40: 2076-80(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

A previously proposed model used to predict transient stabilization in high-current superconductive solenoids is assessed in the light of results on actual test magnets made with a variety of fabrication parameters. The possibilities for the use of the model are discussed with reference to the missing elements and when considering special "short-sample" measurements on thermal propagation characteristics and magnetization characteristics. Results of recovery-current tests are presented. (auth)

**30498** COUPLING OF (Ti–Nb) FILAMENTS IN A SUPERCONDUCTING MULTIFILAMENT COMPOSITE CONDUCTOR. McInturff, A. D. (Brookhaven National Lab., Upton, N. Y.). J. Appl. Phys., 40: 2080-2(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Magnetization measurements were performed on variously prepared samples of multifilament (Ti–Nb) and Cu composites. All measurements were performed at 4.2°K, utilizing peak magnetic fields of 50 kG. The magnetization data were obtained in a manner similar to that described in earlier papers. The impetus for these particular measurements was the hypothesis of P. F. Smith in regard to the coupling of the small filaments of superconductors when they are embedded in a low-resistivity matrix such as Cu. This coupling, of course, is a function of $\partial Ha/\partial t$, but for very long lengths (e.g., magnets), or even short lengths in the case of well annealed Cu, the time constant for the decoupling is extremely long. The coupling, it was suggested by Smith, could be reduced by increasing the resistance of the matrix material, and then twisting the composite, the equivalent of "transposition" of the individual filaments in a two-dimensional case. Various resistance layers are formed around each strand by the proper heat treatment of these multifilament composites. The filaments of the sample composites were found to be decoupled to varying degrees depending on applied magnetic field, sample length, and matrix resistivity. (auth)

**30499** LOSS MEASUREMENTS ON TWISTED MULTIFILAMENTARY SUPERCONDUCTING WIRES. Dahl, P. F.; Morgan, G. H.; Sampson, W. B. (Brookhaven National Lab., Upton, N. Y.). J. Appl. Phys., 40: 2083-5(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Measurements have been made on the energy losses produced during pulsed operation of several superconducting magnets. The coils were made from Nb–Ti wires with solid and multifilamentary cores and pulsed to approximately 25 kG. A comparison was made between the losses produced in magnets made from the two types of conductor. The multifilamentary wire was tested first with the filaments straight, and then after the wire had been twisted with a pitch of 2 turns/cm. The losses for both the solid core and the untwisted multicore conductors were essentially identical and increased as the cube of the maximum field. The losses in the magnet made from the twisted material showed a drastic reduction at high fields with the loss varying as the first power of the maximum field. (auth)

**30500** FREQUENCY DEPENDENCE OF THE SKIN DEPTH IN SUPERCONDUCTING TIN. Matisoo, J. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys., 40: 2091-7 (Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

The first measurements of the frequency dependence of the real part of the superconducting skin depth $\delta_r(v,t)$, in polycrystalline tin films, are reported using a new technique of measurement. The technique is similar to the usual cavity technique, except that the cavity in question is a rectangular $Sn-SnO_x-Sn$ Josephson tunnel junction. The cavity is self-excited via the ac Josephson effect; the resonant frequencies of the cavity are measured from which $\delta_r(v,t)$ is deduced. The measurements extend from $0 \leq v \leq 220$ GHz and $0.5 \leq t \leq 0.952$. The results are compared with Miller's calculations of $\delta_r$ for Sn, which are based on the Mattis–Bardeen theory and are found to be in agreement for $t \leq 0.800$. Above this temperature only qualitative agreement exists because the assumptions under which the calculations were made are here only partly satisfied. (auth)

**30501** MEASUREMENTS OF THE KINETIC INDUCTANCE OF SUPERCONDUCTING LINEAR STRUCTURES. Meservey, R.; Tedrow, P. M. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 40: 2028-34(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

The kinetic inductance $L_k$ is associated with the inertial mass of current carriers. For a long superconductor of length l and very small cross-sectional area σ, $L_k = (m^*/n_s e^{*2})\,(l/\sigma)$ and is the main contribution to the temperature-dependent inductance $L_T$. $L_T$ was measured in superconducting tin wires and thin film meander lines by a technique which uses a counter to determine frequency changes of a 15 MHz tunnel-diode oscillator whose tank circuit contains $L_T$. The measured frequency changes are proportional to $z = [\lambda(t)/\lambda(0)]_{BCS}$ for wires and thick films; for thin films the frequency changes are proportional to $z^2$. This result agrees with calculations of $L_T$ from the London theory and the values of $\lambda(0)$ agree well with the values expected for these samples. This technique allows measurement of the carrier concentration or penetration depth in thin films over the whole H, T plane of the superconducting state and can be independent of the penetration law assumed. Frequency shifts observed with thin film aluminum meander lines have been used to detect changes of temperature of $5 \sim 10^{-7}$°K, changes of magnetic field of $10^{-8}$ G, and changes of current associated with one quantum in a flux quantum magnetometer. (auth)

**30502** APPLIED SUPERCONDUCTIVITY CONFERENCE, GATLINBURG, TENNESSEE, 28–30 OCTOBER 1968. J. Appl. Phys., 40: 1993-2163(Apr. 1969). (CONF-681057).

Of the 59 papers given at the conference, 32 are presented here in full, 18 in abstract form, and 9 by title only. Separate abstracts were prepared for each of the 32 full papers. (M.H.R.)

*For abstracts of individual papers see: 29075–29077, 29276–29281, 30485–30501, 30503–30506, 30640, and 30895.*

**30503** HEAT TRANSFER FROM CYLINDRICAL SURFACES TO LIQUID HELIUM I. Efferson, Kenneth R. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 40: 1995-2000(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Heat transfer from a cylindrical copper surface to liquid helium at 4°K was measured. The sample consisted of a horizontally mounted 3-mm OD, evacuated glass tube, 6.5 cm long, onto which was deposited a 2000 Å-thick copper film. It was heated by passing an electrical current through the copper film, and the temperature was monitored by a carbon resistor attached to the inside of the glass tube with varnish. In initial experiments, large temperature fluctuations were observed in the nucleate boiling region. These temperature fluctuations disappeared when the sample was either close to the liquid helium surface or when vertical walls were placed around the sample. The large temperature fluctuations were probably due to interactions of the convective flow of liquid helium with the boundaries of the system (Dewar walls, liquid surface, etc.). Similar temperature fluctuations were observed with a stainless steel sample of approximately the same dimensions. The peak heat flux obtained

in the nucleate boiling regime was 0.98 W/cm² for Cu and 0.66 W/cm² for stainless steel. (auth)

**30504** SUPERCONDUCTING STUDIES IN A15 PSEUDO-BINARY SYSTEMS. Blaugher, R. D. (Westinghouse Electric Corp., Baltimore); Pessall, N.; Patterson, A. J. Appl. Phys., 40: 2000-2(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Superconductivity studies were performed on some A15 pseudo-binary systems to determine whether low-temperature annealing, conducive to atomic ordering, will markedly raise the superconducting transition temperature. The following systems were examined for this behavior: $Nb_3Ge-Nb_3Al$, $Nb_3Sn-Nb_3Al$, and $Nb_3Ga-Nb_3Al$. Greater attention was devoted to the Nb–Al–Ge system in view of the recent observation of superconductivity above 20°K in this system. Transition temperatures approaching 20°K were also observed in nearly single phase samples of Nb–Al–Ge after low-temperature heat treatment at 700 and 800°C. It is suggested that crystallographic long-range ordering is responsible for the high $T_c$'s observed in this system. Attempts to confirm this hypothesis by determining the degree of long-range order were unsuccessful. The other A15 systems investigated also exhibited an increase of $T_c$ with low-temperature heat treatment; however, none exceeded 18°K. (auth)

**30505** MAGNETORESISTANCE OF COPPER AT 4.2°K IN TRANSVERSE FIELDS UP TO 100 kG. Benz, M. G. (General Electric Research and Development Center, Schenectady, N. Y.). J. Appl. Phys., 40: 2003-5(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

Many high-field superconducting systems make use of copper as part of the conductor configuration. Copper is present primarily because it combines low resistance with moderately high strength. As copper is exposed to high transverse magnetic fields its resistance increases. This resistance increase, or magnetoresistance, has been experimentally measured for several different grades and tempers of commercially available copper at 4.2°K and in the field range from 0 to 100,000 G. Zero field-resistance ratios varied from 60 to 1200 due to differing degrees of purity and amounts of cold work. The results of these measurements fit a normalized equation of the type which gives the fractional change in resistance as a function of transverse field and zero field-resistance ratio. The mechanical properties for these samples have been measured at room temperature and 4.2°K and the yield stress correlated with the resistance properties. (auth)

**30506** PREDICTION OF TRANSIENT STABILITY LIMITS FOR COMPOSITE SUPERCONDUCTORS SUBJECT TO FLUX JUMPING. Iwasa, Y.; Weggel, C.; Montgomery, D. B.; Weggel, R.; Hale, J. R. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 40: 2006-9(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

A computer model is described which is capable of predicting the maximum current, the "threshold current," which can be carried without quenching a Nb–Ti copper composite superconductor undergoing flux jumping. The model utilizes standard equations governing the generation and flow of heat in a wire to predict its voltage-versus-time response as a function of current. Calibration of the model for any specific thermal environment is done by means of a simple test procedure involving measurement of the response following the triggering of a flux jump in a small non-inductively wound solenoid to one of four layers. The combination of theoretical and experimental techniques indicates the value of adequate copper cross section and good thermal environment, and suggests the superiority of porous fabric or cadmium foil over more conventional interleaving materials, and of thin insulation over the alternatives of thick insulation or none at all. (auth)

**30507** A STUDY OF PERSISTENT CURRENTS IN SUPERCONDUCTING NIOBIUM WITH 25 PERCENT ZIRCONIUM. File, Joseph. New York, Columbia Univ., 1968. 246p.

Thesis.

The decay of the magnetic field produced by a persistent current flowing in a superconducting solenoid wound with Nb–25% Zr wire was measured at various values of the self-induced magnetic field. The field was varied through the approximate range of 7 to 832 gauss below the critical field. The results of these experimental runs indicate that over the range of values of the field, the logarithm of the decay rate varies linearly with the field. An estimate of the size of a flux bundle can be made from the result and is $5 \times 10^{-6}$ cm. (Diss. Abstr.)

**30508** ANOMALOUS NUCLEAR SPIN–LATTICE RELAXATION IN THE MIXED STATE OF SUPERCONDUCTING NIOBIUM. Rossier, D.; MacLaughlin, D. E. (Faculte des Sciences, Orsay, France). Phys. Rev. Lett., 22: 1300-3(June 16, 1969).

The $^{93}Nb$ spin–lattice relaxation time $T_1$ in the mixed state of niobium metal was observed to depart at high temperatures from the temperature and field dependence predicted by the theory of gapless superconductivity. This anomaly indicates either a breakdown of the gapless theory or, more plausibly, the existence of a new relaxation mechanism at high temperatures. (auth)

**30509** THE KAPITZA EFFECT IN THE LIQUID AND VAPOR PHASES OF $^3He$ AND $^4He$. Sawyer, Samuel Prentiss. Columbus, Ohio, Ohio State Univ., 1968. 149p.

Thesis.

The thermal boundary resistance at a copper surface in several low-temperature fluids was measured between 1.5 and 4.5°K by using a copper-guard-ring conductance cell with a plate separation of less than 7 microns. In gaseous $^3He$ and $^4He$ a boundary resistance independent of pressure can be distinguished from the pressure-dependent resistance expected from kinetic theory. Measurements in the gases extended over the pressure range from .01-mm Hg (where the gas-kinetic effect becomes dominant) to the saturated vapor pressure. Theory attributes the thermal boundary resistance to an acoustic mismatch between the copper and helium. This mismatch is reduced considerably by an acoustic matching layer of denser helium adsorbed on the surface by van der Waals' forces. The measurements give strong evidence that the remaining mismatch occurs mostly between the copper and the first monolayer of adsorbed helium. An interesting feature of the data is the appearance at 3.2°K of a broad minimum in the boundary resistance for liquid and for gaseous $^4He$. In recent specific heat measurements of submonolayer films of $^4He$ [McCormick, et al., Phys. Rev. 168, 249(1968).] an extremum has been observed at the same temperature. It was suggested that possibly this extremum "is due to a diffuse melting transition between a disordered solid-like and a liquid-like surface phase." Several independent factors discussed support that suggestion. (Disser. Abstr.)

**30510** SPECIFIC HEAT OF LIQUID $^3He/^4He$ MIXTURES NEAR THE JUNCTION OF THE LAMBDA AND PHASE-SEPARATION CURVES. Alvesalo, T.; Berglund, P.; Islander, S.; Pickett, G. R.; Zimmermann, W. Jr. (Technical Univ. of Helsinki, Otaniemi, Finland). Phys. Rev. Lett., 22: 1281-3(June 16, 1969).

The specific heat of liquid $^3He/^4He$ mixtures has been measured at saturated vapor pressure for three values of the $^3He$ mole fraction x near the junction of the lambda and phase-separation curves. The specific heat at the lambda peak appears to be finite, continuous, and cusped. Both the lambda peak and the anomaly in the specific heat as the system goes from the two-liquid-phase region to the one-liquid-phase region tend to disappear as the junction of phase boundaries is approached. (auth)

**30511** OBSERVATION OF ENHANCED DIAMAGNETISM ABOVE $T_c$ IN INDIUM DUE TO THERMODYNAMIC FLUCTUATIONS. Gollub, J. P.; Beasley, M. R.; Newbower, R. S.; Tinkham, M. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett., 22: 1288-91(June 16, 1969).

A temperature-dependent enhanced diamagnetism was observed above the critical temperature in pure bulk indium which is attributed to the effects of thermal fluctuations. The magnitude of the effect and the manner in which it scales with magnetic field are in agreement with a finite-field generalization of a zero-field result based on the Ginzburg–Landau theory. (auth)

**30512** SCATTERING OF POSITIVE IONS BY ELEMENTARY EXCITATIONS IN SUPERFLUID HELIUM. Schwarz, K. W.; Stark, R. W. (Univ. of Chicago). Phys. Rev. Lett., 22: 1278-80(June 16, 1969).

Measurements of the positive-ion mobility in He II are reported, and are analyzed in terms of scattering by elementary excitations. (auth)

**30513** INVESTIGATION OF A NEW KIND OF ENERGETIC NEUTRAL EXCITATION IN SUPERFLUID HELIUM. Surko, Clifford Michael. Berkeley, Calif., Univ. of California, 1968. 64p.

Thesis.

Evidence is presented for the existence of a new kind of neutral excitation generated in superfluid helium in the presence of a $^{210}Po$ alpha-particle source. The flux of neutral excitations is negligibly small above 0.6°K and increases as the temperature is decreased. The neutral excitations travel in the liquid at low temperatures through distances greater than 1 cm without appreciable scattering or attenuation. They produce $He_2^+$ ions and electrons at the free surface of the liquid, and positive ions and electrons at a suitable metal plate immersed in the liquid. Experiments indicate that these neutral excitations are not photons. A possible model for the neutral is some kind of exciton. In addition evidence is also presented that, at temperatures below 1°K, electrons within superfluid

helium may emerge from the liquid into the vapor above its surface when they arrive at the liquid surface trapped in vortex rings. No such behavior is observed for positive ions. (Diss. Abstr.)

**30514** MAGNETIZATION STUDIES IN $Nb_3Sn$ AND Ti–Nb ALLOYS. McInturff, A. D. (Brookhaven National Lab., Upton, N. Y.); Paskin, Arthur. J. Appl. Phys., 40: 2431-40(May 1969).

Magnetization measurements were performed on commercial $Nb_3Sn$ and Ti–Nb alloy samples to determine hysteretic loss (magnetization vs magnetic field) and flux-jump stability at 4.2°K in magnetic fields up to 9.3 $Wb/m^2$. The aforementioned superconducting properties were also observed and recorded with various geometries, field sweep rates and thermal environments. The samples consisted of ribbons and/or wires ranging in size from 1.0 to 0.1 cm wide and 0.1 to 0.0001 cm thick. The transport currents ranged from a few amperes to greater than a thousand amperes. These data were obtained utilizing an experimental setup similar to that described by Fietz. The shape and magnitude of the magnetization curves with and without the presence of transport current was not a function of frequency in the range employed, 0.012 to 3.0 $Wb/m^2 \cdot min$, except for the multifilament composites. The magnetization and flux-jump stability was found to be a function of the sample dimensions, as would be expected with the earlier expressions given by Wipf, Hancox, Chester, and Stekly. The transport current density was not a function of the dimensions. These data on magnetization and transport current effects are in accord with earlier work by LeBlanc and co-workers on Nb–Zr. There is a first principle derivation of the flux-pinning effects that uses a Josephson junction tunneling model and results in the Kim–Anderson expression. The internal field distribution could be characterized by $H_{int}(x) = (H_a - H_1) \exp(-x/\lambda) + H_1$, $\lambda = (H_1 - H_a)/J_c(H_a)$. The exponential expression for $J_c(H_a)$ vs $H_a$ of Fietz et al. fits the sample data; however, the Kim–Anderson expression that would be the first term in the expansion of the exponential would also fit the observed data within the experimental error. The data concerning transport current and magnetization can be accurately accounted for (in the infinite sheet configuration) by expressions derived by Yasukochi. The thin plate geometry, with the proper demagnetization factor, is in agreement as well. (auth)

**30515** MACROSCOPIC CONFIGURATION OF MAGNETIC FIELDS AND ELECTRIC CURRENTS IN TYPE II SUPERCONDUCTORS. Chang, Christopher Teh-min. Los Angeles, Univ. of Southern California, 1968. 207p.
Thesis.

According to prevailing views, a critical current density $j_c$ is attained in type II superconductors when the Lorentz force density $\vec{F}_L \equiv \vec{j} \times \vec{B}$ equals the pinning force density $F_P$ due to defects and impurities. It is presently believed that, to a good approximation, the pinning force density can be written as $F_P = \alpha - \frac{1}{2}\beta$ where $\alpha$ and $\beta$ are temperature dependent parameters of the material. This relation implies that $F_P$ is independent of the magnetic field intensity B. A variety of evidence is presented showing that the pinning force density increases as B increases when $B \ll H_{c2}$ where $H_{c2}$ is the upper critical field for bulk superconductivity. The magnetic behavior of simulated infinite slabs constructed with $Nb_3Zr$ ribbon and wire in magnetic fields parallel to the surfaces of the slab and perpendicular to the induced and conduction currents was extensively studied. Relations of the form $j_c B_\perp = \alpha_n B_\perp^n$ were used in calculations and results are compared with the data. Pursuing suggestions from the literature n = 0, ½, and 1 was chosen and it was found that calculations using n = ½ consistently yield the best agreement with experiment. This result indicates that $F_P$ varies approximately as $B^{\frac{1}{2}}$. The residual magnetization of solid cylinders of Nb, NbTi and $Nb_3Zr$ after a half-cycle perturbation of the applied axial field was investigated. A comparison of the experimental results with calculations based on critical state functions of the form given above indicates that best agreement is obtained when $n \approx \frac{1}{2}$ to ¾. Thus, these 3 materials, although they differ considerably in the parameters used to characterize type II superconductors, obey approximately the same power law for $F_P$. Pursuing the viewpoint that $F_P = \alpha_n B^n$ and realizing that it is the total magnetic field $B = \sqrt{B_\perp^2 + B_\parallel^2}$ which appears in the pinning force density whereas it is only $B^\perp$, the component of B perpendicular to the current density which determines the Lorentz force density, the critical threshold was investigated for induced and conduction currents $\vec{j}$ flowing at an angle with respect to $\vec{B}$. In these circumstances, the critical state relation can be written $j_c B^\perp = \alpha_n (B_\perp^2 + B_\parallel^2)^{n/2}$. This predicts an increase in $j_c$ for a given $B_\perp$ as $B_\parallel$ increases. Such an increase was observed and a good fit to the data for $Nb_3Zr$ was obtained using n = 0.7. The critical-state concept was successfully applied to the description of the magnetic behavior of nonideal type-II superconductors as the external field H is varied at constant temperature T. This concept was extended to the description of the complicated variations of the magnetization of these materials as T is gradually varied at constant H after a variety of previous histories. A variety of experiments are presented which demonstrate that the surface layer of nonideal type-II superconductors can support appreciable supercurrents in the presence of magnetic fields parallel to the surface of the sample and perpendicular to the currents throughout the entire range $0 < H < H_{c2}$. The polarity of these currents can be either diamagnetic or paramagnetic. Further it is shown that a paramagnetic current "spontaneously" arises in this surface layer as a sample cools from $T_c$ in a static magnetic field. (Diss. Abstr.)

# Plasma and Thermonuclear Physics

**30516** (CLM-LM-3/69) CTO SERIES: A LIST OF AVAILABLE CULHAM LABORATORY TRANSLATIONS 1 TO 500. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Apr. 1969. 26p. Dep.

## *Confinement and Heating*

*Refer also to abstract 30561.*

**30517** (IPP-3/87) CONFINEMENT AND HEATING OF PLASMA BY NONLINEAR INTERACTION WITH LASER RADIATION. Hora, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar. 1969. 14p. Dep.

At ruby or neodymium glass laser intensities exceeding $L^* \approx 10^{14}$ $W/cm^2$ a ponderomotive force is produced towards low electron densities in inhomogeneous plasma surfaces near the cutoff density. Under steady-state conditions, the final velocity of the ions is integrated, details of the density profile being cancelled. The energy of the ions accelerated to the vacuum is equal to the mean oscillation energy of the electrons if the elevated electromagnetic energy density in the plasma due to collective effects is taken into account. The pronounced onset of the nonlinear, electrodynamic acceleration mechanism at the threshold energy $L^*$ is due to the fact that the ion energy rises with the fourth power of the light intensity. Above $L_0 \approx 10^{15}$ $W/cm^2$ the total laser energy is converted into directed ion motion only. Between $L^*$ and $L_0$ a D–T plasma of solid-state density can be heated sufficiently with a $10^2$ j laser pulse of length 0.5 nsec to achieve the Lawson criterion to within a factor of 3. (auth)

**30518** (MATT-679) PARTICLE TRAJECTORIES IN STATIONARY TRAPPED-PARTICLE MODES. Jablon, C. (Princeton Univ., N. J. Plasma Physics Lab.). May 1969. Contract AT(30-1)-1238. 17p. Dep. CFSTI.

The influence of stationary electrostatic potential on the trajectories of particles trapped between magnetic mirrors in a toroidal geometry is studied. The particle movement in an axisymmetric situation is first discussed. An irregular electrostatic potential was next introduced and the movement was studied in this case. In addition to the classical "superbanana excursion" it was shown that under certain circumstances a total de-trapping of the particle occurs, which can prevent this type of excursion. The case of a Tokamak-like geometry (but with strong rotational transform, like a stabilized pinch or Levitron) and the influence of the perturbation on the location of the turning points were studied. Some computed results are shown and an analytic approximate expression is derived for this case. (auth)

**30519** (MATT-Trans-86) STUDY OF THE POSSIBILITIES OF INJECTING PLASMA INTO A STELLARATOR VIA A DIVERTER. Zikov, V. G.; Rudnev, N. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Princeton Univ., N. J., from report FTI-63. 30p. Dep. CFSTI.

Experiments to study the motion of a plasma injected through the slit of a diverter manufactured for the Sirius stellarator are described. Injection took place from a coaxial source. The spread of the plasma inside the diverter chamber was observed by means of a plasmascope for various magnetic field intensities (up to 20 kOe. The density of the trapped plasma was estimated as a function of the magnetic field intensity with the help of an eight-millimeter interferometer. A shielded electric probe was used to measure the plasma density distribution with respect to the chamber cross section and the total number of trapped particles. (auth)

**30520** (NP-17896) RELATION OF COEFFICIENT OF TRANSVERSE DIFFUSION OF CHARGED PARTICLES OF PLASMA IN A MAGNETIC FIELD TO ELECTRON TEMPERATURE. Budnikov, V. N.; Golant, V. E. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). 1968. 7p. (In Russian). Dep.

In previous works (Zh. Tekh. Fiz., 37: 861(1967) and 38: 28

(1968)), steady-state plasma formed under the action of uhf power in the electron cyclotron resonance regime was studied. With microwave sources in the 3-cm range and magnetic fields up to 3400 Oe, plasma was created in dielectric and metallic cylinders of diameter 2.5 cm and lengths up to 80 cm, on being filled with hydrogen at pressures of $3 \times 10^{-5}$ to $5 \times 10^{-2}$ mm Hg. These experiments showed the accelerated transverse drift of charged particles characterized by times of 2 to 3 orders of magnitude greater than the times of collision transverse diffusion. On comparing data of these experiments with that of other authors working under similar conditions, it was found that at low temperatures ($T_e < 10$ eV) the values of the transverse diffusion coefficients are close to Bohm coefficients; however, with increased temperatures they prove to be essentially less than Bohm. The transverse diffusion coefficients show little change over wide limits of temperature change (1 to $10^3$ eV). Oscillations were discovered corresponding to the range of drift frequencies, and experimental conditions correspond to theoretical conditions for emergence of drift-type instabilities. Although the anomalous transverse diffusion must be related to instability, its nature can be completely understood only by a more detailed investigation of the spectrum of oscillations. (TSS) (tr-auth)

**30521** (NP-17897) DETERMINATION OF THE TRANSVERSE DIFFUSION COEFFICIENT IN PLASMA WITH HIGH ELECTRON TEMPERATURE IN MAGNETIC FIELD. Budnikov, V. N. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). 1968. 7p. (In Russian). Dep.

Using apparatus described earlier (Zh. Tekh. Fiz., 37: 851(1967) and 38: 28(1968)), experiments were conducted concerning the dependence of the minimum pressure for the existence of discharge in a homogeneous magnetic field on the length and diameter of the plasma. Results indicate that the minimum pressure for existence of discharge does not depend on plasma length within the limits of the experiment, i.e., 10 to 70 cm. The cessation of the discharge was not related to the longitudinal drift of the charged particles. An explanation is offered for the fact that the charged-particle losses are related only to transverse drift. The minimum pressure, charged-particle lifetime, and diameter should be related as follows: $p_{min} \sim 1/\tau_\perp \sim 1/d^2$. The experimental data, however, contradict this relationship, and attempts are made to explain this. (TSS) (tr-auth)

**30522** CORRELATION OF MAGNETIC MOMENT VARIATION IN AXISYMMETRIC AND MULTIPOLAR MAGNETIC MIRRORS. Roth, J. Reece (Lewis Research Center, Cleveland). Plasma Phys., 10: 809-18(Sept. 1968).

A computer solution is given to the equations of motion for more than $10^5$ sets of particle initial conditions which resulted in non-adiabatic behavior, in the sense that the magnetic moment varied by more than 5% during a single interaction with a magnetic mirror. Particle motion in axisymmetric magnetic mirrors and in the minimum-B configuration formed by the superposition of a multipolar (Ioffe) magnetic field on an axisymmetric mirror field were both investigated. The initial conditions which lead to violation of the 5% criterion of adiabaticity can be correlated in terms of a power-law similarity relation if certain dimensionless similarity parameters are used. The same dimensionless similarity parameters and similarity relations, with different values of the numerical constants, can be used to correlate previously obtained experimental data on non-adiabatic losses from magnetic mirror geometries. (auth) (UK)

**30523** PLASMA CONTAINMENT IN A QUADRUPOLE CONFIGURATION. Harries, W. L.; Yoshikawa, S.; Palladino, R. W. (Princeton Univ., N. J.). Phys. Fluids, 12: 1115-23(May 1969).

The containment times of afterglow plasmas in hydrogen, helium, and neon were measured in a linear quadrupole machine (LM-1), where $n_e \lesssim 2 \times 10^{12}$, $T_e \lesssim 10$ eV, $T_i < 1$ eV, mean free path $\lambda \lesssim 100$ cm, connection length $\approx 20$ cm, and electron-ion collision time $\approx 10^{-7}$ sec. Particle collectors showed the losses to be mainly radial. The plasmas in the $\oint dl/B$ stable region decayed in times of order a millisecond (about 10 times the Bohm value) which increased with $I_Q$, the conductor current, to a roughly constant value, and decreased as $T_e$ increased. An axial magnetic field which introduced shear ($\theta \geq 1/30$ rad/cm for the main plasma) caused negligible change to the containment time in helium, with a slight improvement in neon. Various instabilities were observed. Pronounced variations in probe signals and plasma loss rates at different axial positions suggested a convective structure which persisted in the afterglow for some milliseconds. The origin of the radial loss inside the stable region may be due to a low-frequency flutelike mode or possibly to the convective structure in the plasma. (auth)

**30524** NEGATIVE V'' SYSTEM WITH DEEP MAGNETIC WELL. Ikuta, Kazunari (Nagoya Univ., Japan). Phys. Fluids, 12: 1110-11(May 1969).

Closed nested toroidal magnetic surfaces with very strong negative V'' property are obtained for the combinations of simple toroidal field, bumpy poloidal field, and conventional l = 1 helical one. Well depth is estimated to be more than 80%. (auth)

## Diagnostics

**30525** (IPP-3/88) MEASUREMENT OF THE ION TEMPERATURE IN A HYDROGEN ARC BY MEANS OF THE THERMAL DOPPLER EFFECT. Ludwig, D. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar. 1969. 60p. (In German). Dep.

The radial ion temperature distribution in a 2600 A hydrogen arc in a 30 kG axial magnetic field was measured spectroscopically with a Fabry-Perot interferometer by evaluating the half width of Doppler broadened carbon lines. As the admixture of methane had to be low, in order to prevent a strong reduction of the temperatures on the axis, the intensities of the C III and C IV lines were relatively weak. Consequently an interference filter with narrow transmission band width was used instead of a spectrograph in front of the interferometer. The broadening of the spectral lines, which were used for measurement, was caused mainly by the thermal Doppler effect. The rotation of the plasma and the macroscopical Doppler effect resulting therefrom did not disturb the measurements. The ion temperature, which was found to be $1.4 \times 10^5$ °K on the axis, was determined from the half width of the profiles of a C III spectral line. Since the discharge was observed side-on, the measured integrated values were reduced to radial profiles by using appropriate inversion formulas. (auth)

**30526** (STI/PUB-21/35) LASER APPLICATIONS IN PLASMA PHYSICS (1962-1968). Bibliographical Series No. 35. (International Atomic Energy Agency, Vienna (Austria)). Mar. 1969. 234p. IAEA: $6.00; Austrian Schillings 155,-; £2.10.0; F Fr 29,40; DM 24,-.

The bibliography deals with both experimental and theoretical aspects of plasma diagnostics and plasma production by lasers. It contains 735 references, almost all with abstracts, to the literature in English, French, Russian, German, Italian, and other languages, published during the period 1962-July 1968. Author and subject indexes are included. (M.O.W.)

**30527** DIFFUSION THEORY FOR THE SPHERICAL LANGMUIR PROBE. Blue, E.; Ingold, J. H. (Lockheed Research Lab., Palo Alto, Calif.). Plasma Phys., 10: 899-901(Sept. 1968).

A summary is given of the results of a theoretical study of the effect of elastic collisions between charged particles and gas atoms on Langmuir probe current-voltage curves. The formulation is identical to that of previous treatments by Cohen and by Radbill, except for a change in the boundary condition by which the electron (ion) density is specified at the probe surface. (UK)

**30528** ELECTRON TEMPERATURE AND DENSITY AND GAS TEMPERATURE MEASUREMENTS IN AN ARGON AFTERGLOW. Donovan, B. V.; Sexton, M. C. (University Coll., Cork, Ireland). Electron. Lett., 5: 185-97(May 1, 1969).

Microwave and spectroscopic methods of monitoring the time-varying density and temperature of the electrons, as well as the temperature of the neutral background gas, were applied to an argon afterglow. Electron-ion recombination coefficients were extracted from the decay rate over the electron-density range $10^{13}$ to $10^{11}$ $cm^{-3}$, concerning which little information has previously been reported. (auth) (UK)

**30529** MEASUREMENTS OF IONIC SPECIES PRESENT IN RF DISCHARGES OF ARGON AND ARGON-CESIUM. Gilkinson, J. L.; Held, Herman; Chanin, L. M. (Univ. of Minnesota, Minneapolis). J. Appl. Phys., 40: 2350-6(Apr. 1969).

Mass spectrometric measurements have been made of the ions present in rf discharges of argon and argon containing small concentrations of cesium. Data were obtained for normalized argon and cesium pressures up to 3 and $4 \times 10^{-3}$ torr, respectively. The relative ion signals are functions not only of the argon and cesium concentrations but also of the plasma excitation power. For argon-cesium mixtures the primary ions that are observed are $Ar^+$, $Ar_2^+$, and $Cs^+$. Analysis of the data for $Ar^+$ and $Ar_2^+$ suggests that $Ar_2^+$ is produced by both Hornbeck-Molnar and three-body conversion processes. Interpretation of the results leads to the conclusion that in the present study $Cs^+$ is formed by both direct ionization and by collisions of argon metastables with neutral cesium. (auth)

**30530** EXPERIMENTAL STUDY OF TORSIONAL ALFVEN WAVES IN CYLINDRICAL PLASMAS. Shimada, Tzutomu; Sugita,

Keiichiro; Nagao, Shigeo (Tohoku Univ., Sendai). Technol. Rep. Tohoku Univ., 33: 307-24(1968).

Experimental results on small amplitude Alfvén waves in cylindrical plasma in the magnetic field agreed well with the hydromagnetic wave theory, given by the linear approximation. The Alfvén wave with a small amplitude is thus considered to be a useful tool in plasma diagnostics. It was shown that the nonlinear Alfvén wave can also be excited in the plasma column, and the effects of reionization and plasma heating due to the passage of the wave with large amplitude were observed by microwave and spectroscopy techniques. Thus, the re-ionization due to the wave in afterglow plasma was measured by 50-GHz microwave interferometry and it was considered as one of the nonlinear effects. The sufficiently large amplitude Alfvén wave has the effect on the plasma heating which was observed by the He-line intensity ratio. The effect of the plasma heating was explained qualitatively by the oblique hydromagnetic shock theory. It was found that the increase of plasma temperature is proportional to the square of the wave amplitude. (BBB)

**30531** METHOD FOR DETERMINING ELECTRON VELOCITY DISTRIBUTION FUNCTION IN GASEOUS PLASMA. Stainov, G. Z.; Nedyalkov, I. P. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 22: 129-32(1969).

A method for the determination of the electron velocity distribution function f(u) in gaseous plasma is submitted, in which the collective oscillations are excited and the relationship between the complex frequency $\omega = \omega' + j\omega''$ and the complex wave number $k = k' + jk''$ is known. The electron oscillations in an infinite, homogeneous, and isotropic plasma which is free from outer fields and in which the ions are considered as immobile are examined. (M.O.W.)

**30532** ELECTRIC ARCS. Wiese, W. L. pp 307-53 of Atomic and Electron Physics: Atomic Interactions. Part B. Bederson, Benjamin; Fite, Wade L. (eds.). New York, Academic Press, Inc., 1968.

The properties of arcs and the analysis of arc plasmas are discussed from the viewpoint of applications in atomic physics. A detailed description of experimental methods for determination of particle densities and temperatures in arc plasmas is presented. The question of local thermal equilibrium is examined. Applications discussed include the determination of atomic transition probabilities, continuum emission coefficients, line-broadening parameters, and cross sections for elastic scattering of electrons by atoms. 118 references. (A.G.W.)

## *Kinetics (General)*

**30533** ELECTROMAGNETIC PRODUCTION OF SHOCK WAVES. Rebhan, E. (Institut fuer Plasmaphysik, Munich). Plasma Phys., 10: 829-40(Sept. 1968).

When a force is suddenly exerted within a confined region of a flow channel on a gas at rest, a shock wave and a rarefaction wave are set up in opposite directions. This situation arises, with heat being generated in addition, when crossed electric and magnetic fields E and B are suddenly applied to an electrically conductive gas at rest. In dependence on the total force P and the total energy input W per second, the asymptotic solutions are investigated toward which the state of flow converges as force and energy input become stationary. For strong shocks the Mach number is proportional to $P^{\frac{1}{4}}$ and $W^{\frac{1}{8}}$. If the power W is supplied by a battery with fixed data, M as a function of the applied magnetic field B has a maximum. It is supposed that some of the results are also approximately valid for T-tubes at times immediately following the discharge. (auth) (UK)

**30534** INFLUENCING THE DEGREE OF IONIZATION BY DIFFUSION AND MASS CURRENTS IN A PLASMA. Bergstedt, K. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch., 24a: 299-310(Mar. 1969). (In German).

A stationary, magnetically stabilized helium arc plasma is taken as an example to show that ionization degrees in such plasmas with large electron temperature and electron density gradients may not be calculated from static ionization relations valid for homogeneous plasmas (e.g., the Saha equation). Instead, ionization degrees in inhomogeneous plasmas must be determined from continuity equations of the form $\mathrm{div}(n_Z v_Z) = J_{Z-1} n_{Z-1} - R_Z n_Z$ where $J_{Z-1}$ and $n_{Z-1}$ are the ionization rate and the density of the Z – 1 times charged ions, and $R_Z$, $n_Z$, and $v_Z$ are the recombination rate, the density and the center-of-mass velocity of the Z times charged ions. Static ionization formulas may not be applied to inhomogeneous plasmas because the finite relaxation times for the attainment of static ionization equilibria result in these ionization equilibria being displaced by the motion of the ions parallel to the direction of electron temperature and density gradients. This is proved by means of two independent operations: firstly, the velocities of the helium ions, these being governed primarily by ambipolar diffusion, are calculated with the spectroscopically measured state variables from the momentum equations of the plasma; secondly, the velocities of the doubly charged ions are determined by integrating the continuity equation for these ions, use again being made of the measured state variables and of the ionization and recombination rates $J_1$ and $R_2$ of the helium ions that were calculated for this special plasma. The agreement between the independently obtained velocity values proves that the degree of ionization of the helium ions in this inhomogeneous plasma is described not by a static ionization formula, but by the continuity equations for these ions. Furthermore, it is shown that the ionization "equilibria" between singly charged and neutral helium particles and between three times (C IV) and four times (C V) charged carbon particles are not determined by means of static ionization formulas either. The influence of this hitherto disregarded effect on the spectroscopic determination of the electron temperature in the plasma discussed is illustrated in a diagram. (auth)

**30535** PROCEEDINGS OF THE SIXTH INTERNATIONAL SHOCK TUBE SYMPOSIUM, [FREIBURG, GERMANY, APRIL 12-14, 1967]. Phys. Fluids, 12: Suppl. 1, I,1-194(May 1969). (CONF-670407).

Separate abstracts were prepared for 8 of the papers; the remaining papers were not in scope. (M.O.W.)

*For abstracts of individual papers see: 30536, 30537, 30541–30544, 30565, and 30566.*

**30536** THERMAL CONDUCTIVITY OF SHOCK-HEATED ARGON. Bunting, J. O.; Devoto, R. S.; Bershader, D. (Stanford Univ., Calif.). Phys. Fluids, 12: Suppl. 1, I,85-8(May 1969).

From 6th International Shock Tube Symposium, Freiburg, Germany. See CONF-670407.

Optical interferograms have been taken of the thermal layer formed at the end wall of a shock tube after reflection of the incident shock. With the aid of suitable boundary-layer equations, six of these interferograms taken with argon as test gas, have been analyzed under the assumption that the thermal conductivity varies as $T^{\nu}$. The average measured thermal conductivity is then represented by $K = 4.25 \times 10^{-5} (T/300)^{0.66}$ cal/cm sec°K. (auth)

**30537** NORMAL AND TRANSVERSE IONIZING SHOCK STUDIES. Gross, R. A.; Levine, L. S.; Meehan, R. J.; Miller, B. (Columbia Univ., New York). Phys. Fluids, 12: Suppl. 1, I,65-7(May 1969).

From 6th International Shock Tube Symposium, Freiburg, Germany. See CONF-670407.

Recent experimental and theoretical studies of normal and transverse ionizing shocks are summarized. Results of normal ionizing shock studies are reviewed briefly. Transverse ionizing shocks have been observed traveling with speeds and drive currents that are in excellent agreement with a snowplow-type theory. It is noted that small bias fields cause significant shunting of the total discharge current at the launch end of the shock tube while large bias fields inhibit shunting and thereby enhance shock-tube performance. Evidence is presented supporting the hypothesis that this effect is caused by sputtering of heavy-metal vapors from the launch area of the shock tube. (auth)

## *Kinetics (Experimental)*

**30538** (LA-DC-9850) EXPERIMENTS USING A 25 kw HOLLOW CATHODE LITHIUM VAPOR MPD ARC JET. AIAA Paper No. 69-241. Fradkin, D. B.; Blackstock, A. W.; Roehling, D. J.; Stratton, T. F.; Williams, M.; Liewer, K. W. (Los Alamos Scientific Lab., N. Mex.). [1968]. 15p. (CONF-690319-1). Dep. CFSTI.

From AIAA 7th Electric Propulsion Conference, Williamsburg, Va.

The performance is reported of a 25-kW, lithium fueled, applied field MPD arc jet which incorporates a unique feed system with an "open-ended heat-pipe" vaporizer and a hollow cathode. The arc typically operates at currents of 250 to 500 amperes, voltages of 40 to 60 volts, magnetic field strengths between 500 and 3000 gauss, and produces a highly ionized lithium beam which transports 70% of the input electrical power to the beam stop. The ambient tank pressures range as low as $2 \times 10^{-4}$ torr. A comparison of hollow cathode and conventional MPD arc performance is made and it is concluded that the hollow cathode arc is superior to the conventional design. Diagnostic experiments performed in the exhaust plume include the determination of axial ion and atom

velocities by measurements of Doppler shifts with a scanning Fabry–Perot interferometer and of ion energies by use of electrostatic energy analyzers; the determination of ion temperatures by comparison of experimental and calculated spectral line profiles; the determination of electron temperatures and densities with electrostatic probes; and the determination of current densities by Rogowski loops. These measurements indicate that at a station 25 cm downstream of the arc head the directed ion velocity exceeds $2 \times 10^6$ cm/sec. At a station 90 cm downstream the plasma typically has an electron temperature of about 2.3 eV, a density of approximately $1.5 \times 10^{12}$ cm$^{-3}$, and under certain operating conditions more than 40% of the arc currents extends 90 cm downstream of the arc head. The efficiency of a process which converts input electrical power into kinetic energy is discussed in terms of a model which sets the plasma into rotation with subsequent expansion in a magnetic field. (auth)

**30539** EXPERIMENTAL STUDY OF A CURRENT SHEET. Alidieres, M.; Aymar, R.; Jourdan, P.; Koechlin, F.; Samain, A. (EURATOM–CEA, Fontenay-aux-Roses, France). Plasma Phys., 10: 841-50(Sept. 1968).

A very thin current sheet was produced by induction, supporting a $\beta = 1$ plasma. It was found to be stable for a period of time which depended on density, and was longer than expected from existing theories of resistive tearing instability. At the end of this period the sheet was rapidly destroyed. This destruction occurred when the electron density was lower than a critical value; an initial breakthrough at one point gave rise to a magnetic field across the sheet which drove the whole current layer out of equilibrium. It is shown that this breakthrough cannot be produced either by unstable ion drift waves or by electrons of the plasma running away, as already observed in other experiments. A new mechanism is needed to explain these results. (auth) (UK)

**30540** EXPERIMENTAL INVESTIGATION OF FORMATION AND ACCELERATION OF LUMINESCENT CURRENT LAYERS IN Z-PINCH DISCHARGES. Kleist, G.; Boetticher, W.; Dammann, H.; Kogelschatz, U. (Univ., Kiel). Z. Naturforsch., 24a: 226-33(Feb. 1969). (In German).

The formation and acceleration of the luminescent current layer in a z pinch discharge (diameter 44 cm, electrode distance 9 cm) has been investigated. From observations of discharges in different gases with filling densities in the range $2.2 \times 10^{-7} \leqq \rho_0 \leqq 6.6 \times 10^{-6}$ g/cm$^3$ a model has been developed for the different structures of the contracting layer. The essential discharge parameters are the density and the electron mean free path in the cold gas. (auth)

**30541** CURRENT STATUS OF RESEARCH ON ELECTROMAGNETICALLY PRODUCED UNSTEADY SHOCK WAVES. Muntenbruch, Helmut (Ohio State Univ., Columbus). Phys. Fluids, 12: Suppl. 1, I,11-21(May 1969).

From 6th International Shock Tube Symposium, Freiburg, Germany. See CONF-670407.

Fast shock waves in light gases can be produced simply by electromagnetic acceleration. Unlike rail spark gaps or magnetic annular tubes, which produce quasistationary, shock-wave-like phenomena, T tubes and conical theta pinches or Z pinches generate nonstationary shock waves of the blast wave type if the plasma of the driving discharge does not advance right into the shock front and appreciably influence the plasma formed there. The investigations of free-running shock waves and the distributions of the parameters in the plasmas behind these shock fronts are discussed. Shadowgraphs, interferograms, microwave interferograms, and probe measurements have afforded a fairly complete picture of such nonstationary waves revealing their uses and limitations. (auth)

**30542** RADIATION GAS DYNAMICS IN THE SHOCK TUBE. Griffith, Wayland C.; Wood, Allen D. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Fluids, 12: Suppl. 1, I,30-6(May 1969).

From 6th International Shock Tube Symposium, Freiburg, Germany. See CONF-670407.

An assessment of the shock tube as an instrument for research in radiation gas dynamics is presented. Principal results obtained since Kantrowitz and Laporte first observed luminous fronts are described and the roles of impurity and nonequilibrium radiation, spectral intensities, rate processes, and continuum radiation are discussed. Spectroscopy was originally used as an aid to understanding problems in gas dynamics at moderate temperatures. More recently the shock tube has been used as a tool for spectroscopic research. The present trend is toward a fusion of these two interests in studying radiation-coupled flows where radiant energy transport affects the flow field. Present day shock tubes with arc-heated drivers attain thermodynamic conditions typical of superorbital speeds—the regime where radiant energy transfer becomes important. The current interest is in determining the radiative properties of gases at these high temperatures (10,000 to 20,000°K). Here the presence of significant amounts of vacuum ultraviolet radiation causes instrumentation problems which hamper investigations at present. However, solutions have been devised. Shock-tube results are compared to current theoretical predictions for the spectrally integrated total radiant intensity of high-temperature air. These reveal differences on the order of a factor of 2 and also clarify certain important areas of future endeavor. These include thermodynamic state measurements of gases shocked to temperatures above 10,000°K, additional measurements of the total intensity, and measurements of the spectral radiant intensity of high-temperature gases. An extensive bibliography is included. (auth)

**30543** RADIATION COOLING BEHIND A STRONG SHOCK IN KRYPTON. Rehder, L.; Boetticher, W.; Carls, H.; Graap, V. (Univ., Kiel). Phys. Fluids, 12: Suppl. 1, I,50-3(May 1969).

From 6th International Shock Tube Symposium, Freiburg, Germany. See CONF-670407.

Strong shocks at Mach numbers from 10 to 15 and at initial pressures between 1 and 10 torr are produced in a conventional diaphragm shock tube. The effect of radiative energy loss from the plasma behind the shock is studied by quantitative measurement of the decay of continuous emission at $\lambda = 4000$ Å. It is shown that for high electron densities the maximum emissivity deviates remarkably from Unsöld's theory. The variation of flow parameters with increasing distance from the shock front is calculated using an iterative method developed by Pomerantz. The results indicate that the observed luminosity decay cannot be explained by losses of continuous radiation alone. The influence of resonance radiation and line emission on the plasma cooling rate is briefly discussed. (auth)

**30544** MEASUREMENT OF IONIZATION RELAXATION TIMES IN SHOCK TUBES. Frohn, A. (Technische Hochschule, Aachen); de Boer, P. C. T. Phys. Fluids, 12: Suppl. 1, I,54-7(May 1969).

From 6th International Shock Tube Symposium, Freiburg, Germany. See CONF-670407.

Ion density profiles for low Mach numbers (7 to 9) have been obtained in a pressure-driven shock tube. In this Mach number range the ionization process is strongly influenced by small amounts of impurities. Various techniques for minimizing the impurity level due to outgassing from the shock tube walls and back diffusion of pump oil are discussed. Preliminary results for argon are described. For air new results for the ionization relaxation time are obtained. (auth)

## *Kinetics (Theoretical)*

**30545** (N–69-19601) ELECTRON MOBILITY IN RANDOMLY LOCATED HARD-CORE SCATTERERS. Neustadter, Harold E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1969. 105p. (NASA-TM-X-52569). CFSTI.

Thesis. Submitted to Case Western Reserve Univ., Cleveland, Ohio.

Kubo's formulation of irreversible quantum statistics is applied to electron mobility. In the weak-coupling limit the approach to equilibrium is shown to be characterized, in the lowest order, by a relaxation time. With the use of wave functions for hard-core interactions a characteristic relaxation time is derived which to "all orders" is independent of the external (small) driving force. For the specific application to mobility the general theory yields the known results of semi-classical kinetic theory at high temperature and low density. For the region of lower temperature and higher density the theory gives qualitative agreement with the anomalous drop in mobility found for electrons in low-temperature helium. However, lack of quantitative agreement indicates a need for further work on the problem. (auth) (STAR)

**30546** (N–69-20176) THERMAL ABSORPTION IN SEEDED GASES. Final Technical Report, February 13, 1968–February 12, 1969. Cory, J. S.; Bennett, A. (McDonnell Douglas Astronautics Co., Richland, Wash. Donald W. Douglas Labs.). Feb. 1969. Contract NASw-1697. 74p. (NASA-CR-100700; DAC-60779). CFSTI.

To study the concept of radiantly heated seeded aerosol temperatures at which the propellant for a gas-core nuclear reactor would become opaque, hydrogen and helium gases were seeded with micron-size particles and exposed to radiant energy from a high-power (40 kW/cm$^2$) xenon flash tube. The experimental apparatus consisted of an elliptical reflector which has as its foci the xenon flashlamp and a 6 by ½ inch quartz cylinder containing the aerosol. Temperature was determined by measuring the pres-

sure in the constant volume quartz cylinder. Tantalum carbide particles produced the highest temperatures, 5300 and 6600°K for hydrogen and helium, respectively. The theoretical model consists of spheres of gas with solid particles at their centers. The model includes reradiation from the particles, heat losses from the gas to the container, temperature dependent values for the heat capacities (seed and gas), and thermal conductivity (seed and gas). Qualitative agreement between this model and the experiment was good, but quantitatively, the theoretical temperatures were too high. Two phenomena were identified as the cause for the disagreement. These were evaporation of the particles, and the chemical reduction of the quartz cylinder inner surface to silicon. (auth) (STAR)

**30547** (SC-DC-69-1772) PLASMA EXPANSION INTO A VACUUM ENVIRONMENT. Mangan, D. L. (Sandia Labs., Albuquerque, N. Mex.). [nd]. 18p. (CONF-690408-1). Dep. CFSTI.

From Southwest Regional Conference, Albuquerque, N. Mex.

Preliminary efforts of an investigation of plasma expansion into a vacuum are discussed. The problem is stated as: Given a finite point source of plasma, determine the number density n(r,t) and the electric field E(e,t) as a function of space and time. (M.O.W.)

**30548** HYDRODYNAMIC EQUATIONS FOR PLASMAS IN STRONG MAGNETIC FIELDS. I. COLLISIONLESS APPROXIMATION. Oraevskii, V.; Chodura, R.; Feneberg, W. (Institut fuer Plasmaphysik, Munich). Plasma Phys., 10: 819-28(Sept. 1968).

A system of hydrodynamic equations for the description of a collisionless plasma is derived. The equations for motion perpendicular to the magnetic field are an extension of those of Chew et al. (1956) and the method of deriving the hydrodynamic equations is an extension of a method used by Grad (1949). This extension is necessary because in collisionless plasma thermal energy is not equally distributed over all degrees of freedom. Therefore consideration must be given to two heat-flux vectors for the transport in thermal energy of parallel and perpendicular degrees of freedom separately. These independent heat-flux vectors are caused by gradients of the parallel and perpendicular temperature respectively. A system of equations is thus arrived at for 16 moments of the distribution function. (auth) (UK)

**30549** SOUND VELOCITY IN MULTITEMPERATURE PLASMA. Pietrzyk, Z. A. (Inst. of Fundamental Technical Research, Warsaw). Arch. Mech. Stosow., 20: 559-64(1968).

The measurement of sound velocity in a plasma enables determination of the temperature of this medium when it is in thermodynamic equilibrium. Information can also be obtained from the measurement of sound velocity in a plasma which is not in a thermodynamic equilibrium. The characteristics of flow of 2-temperature plasma and the sound velocity in such a plasma were determined. The expression for the sound velocity was generalized to the case of a multitemperature plasma. In a plasma not in thermodynamic equilibrium the sound velocity depends on both ion and electron temperatures. The sound velocity in plasma depends also on the ionization degree which, in the absence of equilibrium, is not a unique function of temperature and density but it is an individual parameter. For ionization degree tending to zero, the sound velocity depends weakly on the temperature of electrons but strongly on that of ions. For a heavy gas, the inverse case, that is, the sound velocity may depend more markedly on the electron temperature than on the ion temperature. It was concluded that, in general, no data on plasma temperature can be obtained from the measured sound velocity when thermodynamic equilibrium does not exist. On the other hand, the deviation of plasma from the thermodynamic equilibrium can be estimated by comparing the temperature determined from the calculated sound velocity to that measured using another (e.g., spectroscopic) method. (BBB)

**30550** FUNCTIONAL METHODS IN STATISTICAL MECHANICS. I. CLASSICAL THEORY. Brittin, W. E.; Chappell, W. R. (Univ. of Colorado, Boulder). J. Math. Phys. (N. Y.), 10: 661-74(Apr. 1969).

A statistical-mechanical theory of fields is developed. Since a field has an infinite number of degrees of freedom, it is natural and convenient to use functional methods for its description. The most general statistical-mechanical state for a field is represented by a distribution functional which satisfies a functional differential equation analogous to the Liouville equation. The functional Fourier transform (characteristic functional) is introduced and its properties are studied. Multitime functionals and various reduced distribution functions are also discussed. The formalism is applied to the free electromagnetic fields as well as to a system of charged particles (plasma) interacting via the electromagnetic field. (auth)

**30551** RADIATION FROM AN ELECTRIC DIPOLE IN A COLUMN OF ANISOTROPIC PLASMA. Ohkubo, Motoaki (Gunma Univ., Kiryu, Japan). Electron. Commun. Jap. (Engl. Transl.), 51: 83-8(Jan. 1968).

An analysis of the electromagnetic radiation from an electric dipole located on the axis of an anisotropic cold plasma column, magnetized by a longitudinal d-c magnetic field and surrounded by the air, is made. The electromagnetic fields are of a hybrid-wave type. The field pattern for $H_\phi$ becomes maximum in the direction perpendicular to the axis, but the direction of maximum $E_\phi$ is indefinite. The patterns for both $H_\phi$ and $E_\phi$ are symmetrical with respect to the direction perpendicular to the axis. There are two types of slow waves propagating along the axis without attenuation. One of these decays transversely inside the plasma while the other does not. Radiation patterns are computed. Numerical results of the computation are illustrated. The field patterns are affected by the anisotropy of the plasma in a complex manner with respect to direction and also with respect to the value of $\omega_c/\omega_p$. (BBB)

**30552** VIRTUAL EIGENVALUES AND SINGULAR EIGENFUNCTION EXPANSION IN THE THEORY OF COLD PLASMA OSCILLATIONS. Sedlacek, Z. (Inst. of Plasma Physics, Prague). Z. Angew. Math. Mech., 48: T294(1968).

Small amplitude electrostatic oscillations of a cold nonuniform plasma were investigated. By applying the Laplace transform technique the problem could be reduced to a second-order singular differential equation. The Green function of this equation was constructed and some of its singularities (virtual eigenvalues) were shown to represent the phenomenon of spectral concentration occurring in the continuous spectrum of the differential equation. Singular eigenfunctions associated with the continuous spectrum were obtained in terms of generalized functions by converting the differential equation into an integral equation similar to the equation of neutron transport. The expansion in terms of these eigenfunctions was then shown to be equivalent to the Laplace transform approach. (auth)

**30553** SOME CONSIDERATIONS ON THE RELAXATION PROCESS OF IONIZATION IN A NONEQUILIBRIUM PLASMA. Brunne, M. (Inst. of Fluid-Flow Machines, Gdansk, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Tech., 16: 671-6(1968).

The relaxation process for electrons in a nonequilibrium plasma is considered. The analysis is confined to ionization relaxation. Only the relaxation process caused by a definite source function in the continuity equation for electrons is analyzed. The Kerrenbrock model is used to represent the plasma in the state of statistical nonequilibrium. A solution to the equations of time variation of electron density and energy is of practical interest. It enables the estimation of time required by electrons in equilibrium at temperature $T_{e0} \neq T_a$ to reach the concentration given by the Saha equation at $T_e = T_a$, due to the combined effects of the source processes of ionization and recombination. The evaluation of this is important for the MHD generators, in which the concentration should possibly be maintained at a level corresponding to $T_{e0} > T_a$. $T_{e0}$ is the electron temperature at the instant t = 0. The solution holds for a stationary case as well. Results are shown of numerical computations made for He with constant content of $3 \times 10^{-3}$ Cs seeding, for two different pressures and a range of temperatures. Two kinds of processes are illustrated: relaxation of a nonequilibrium state, and equilibration due to the heating of electrons. (BBB)

**30554** RELATIVISTIC CORRECTION TO BREMSSTRAHLUNG FROM A PLASMA. McBride, John B.; Pytte, Agnar (Dartmouth Coll., Hanover, N. H.). Phys. Fluids, 12: 1130-31(May 1969).

An electron–ion dipole correction of $-15V_T^2/8c^2$ to the transverse bremsstrahlung spectrum is found by including relativistic corrections to the electron kinetics. This correction is of the same order as the electron–ion and electron–electron $k^2\lambda_D^2$ corrections. (auth)

**30555** NONLINEAR EFFECTS IN THE POSITIVE COLUMN OF A MODULATED GAS DISCHARGE. Polman, J. (Philips Gloeilampenfabrieken N. V., Eindhoven, Netherlands). Phys. Fluids, 12: 1128-30(May 1969).

The dc properties of the positive column of a modulated gas discharge are strongly influenced by the modulation, even at small modulation depths. Calculations without linearization of the equations are in reasonable agreement with experiments. (auth)

**30556** ELECTRON DISTRIBUTION FUNCTION IN A SLIGHTLY IONIZED MOVING GAS. Mintzer, David (Northwestern Univ., Evanston, Ill.). Phys. Fluids, 12: 1042-4(May 1969).

The Lorentz gas approximation to the Boltzmann collision operator is generalized to the case of the heavy-molecule gas

distribution function being non-Maxwellian; results are obtained to first order in the mass ratio, but can easily be generalized to higher orders. The equilibrium distribution for the light-molecule gas is then found. The results are applicable to any light-molecule trace gas in a heavy-molecule non-Maxwellian bath gas, and, in particular, to a slightly ionized gas. (auth)

**30557** FORMULATION OF A STATISTICAL THEORY OF STRONG PLASMA TURBULENCE. **Weinstock, Jerome (Environmental Science Services Administration, Boulder, Colo.). Phys. Fluids, 12: 1045-58(May 1969).**

A new formulation of methods introduced by Dupree, and Orszag and Kraichnan, for solving the Vlasov equation for turbulent plasmas based on algebraic use of an averaging operator is described. Formally exact sets of integrodifferential equations are thereby derived for determining the ensemble average of the one-particle distribution function, and the electric field spectrum of turbulent plasmas. The formal difference between these equations and the approximate equations of Dupree, and Orszag and Kraichnan, is that the average "Vlasov" propagator $U(t,t_0)$ of the latter is replaced by a new propagator $U_A(t,t_0)$ which involves the averaging operator. The potential usefulness of the present equations can be judged by the fact that, in a simple lowest-order limit, they immediately reduce to the turbulence equation of Dupree. These equations are used to develop a modified perturbation theory which avoids certain time secularities. Cumulant expansions are introduced to evaluate average "Vlasov" propagators, and to rigorously treat the variation of the diffusion coefficient with velocity. It is explicitly shown that (diffusive) perturbed trajector corrections are equal to mean square deviations from the mean of "Vlasov" trajectories. (auth)

**30558** RELATIVISTIC SHEET PINCHES WITH CURRENT SHEAR. **Holdren, John P. (Stanford Univ., Calif.). Phys. Fluids, 12: 1059-68(May 1969).**

A new class of self-consistent, one-dimensionally confined, neutral solutions to the stationary Vlasov and Maxwell equations is presented. Apart from the special cases of conventional sheet pinches, these equilibria all display current shear (which, in analogy with magnetic shear, is defined as rotation of the current vector as the plasma is traversed in the confined direction). The new solutions are obtained numerically, after the relativistic Vlasov–Maxwell problem has been reduced to a single second-order nonlinear ordinary differential equation for the critical component of the self-consistent vector potential. The physical properties of representative equilibria are given in graphical form. Included in addition to thin sheet pinches are broader configurations with a region of nearly uniform plasma number density, bounded by rather sharp plasma/magnetic-field interfaces. (auth)

**30559** ADIABATICITY OF CHARGED-PARTICLE TRAJECTORIES IN A CUSPED MAGNETIC FIELD. **Leffel, Claude S. Jr.; Gray, Ernest P. (Johns Hopkins Univ., Silver Spring, Md.). Phys. Fluids, 12: 1008-17(May 1969).**

The region of adiabatic charged-particle motion for a spindle-cusp field is determined on the basis of confinement times both by numerical integration of the particle orbits and by an experiment utilizing electrons. If the critical flux line dividing the adiabatic and nonadiabatic regions is expressed in Grad's form, $\psi_c = (a\lambda_0)^3$, where $\lambda_0$ is the cyclotron radius of the particle corresponding to its total velocity, the numerical analysis yields a value for the constant a of 3.5 to 4.2 and the experiment yields $a = 4.36$. It is further shown that the transition zone between the regions of adiabatic and nonadiabatic motion is about two-thirds of an electron cyclotron radius in width, and that the relative field variation encountered during one cyclotron period by an electron whose guiding center is located in this zone is between 11 and 19%. A random-walk model of particle motion, based on the near noncorrelation between fluctuations of the magnetic moment on successive traversals of the field, is used to calculate the effect on particle lifetime of the location of the first reflection point, and thereby explain the apparently excessive random scatter of the data. (auth)

**30560** INFLUENCE OF ION-SOUND OSCILLATIONS ON ELECTROCONDUCTIVITY OF WEAKLY IONIZED PLASMA. **Baimbetov, F.; Tsintsadze, N. L. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR, 53: 317-20(Feb. 1969). (In russian).**

The effect of an increase in time of ion–acoustic oscillations on electric conductivity of weakly ionized plasma is given. It is shown that at $t \sim (M/m)^{\frac{1}{2}}(\nu_{Te}/\nu_0)(1/\gamma_{e_0})$, and above, the existence of oscillations causes an appreciable decrease of electric conductivity. (auth)

## Production

*Refer also to abstract 30526.*

**30561** (NP-tr-1768) PRODUCTION AND HEATING OF PLASMA IN A MAGNETIC FIELD BY HIGH FREQUENCY WAVES. **Golant, V. E. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translation of report 092. 25p. (CTO-531). Dep.**

Experiments are described on the production and heating of plasma in a magnetic field under the action of microwaves in the 3 cm range using a broad band waveguide technique to feed energy to the plasma. The region of existence of a plasma in a homogeneous magnetic field and in magnetic mirror traps was determined as a function of the power input and gas pressure (hydrogen being used for most experiments). It is shown that the region of existence of the plasma is determined by the conditions governing the absorption of the high frequency waves. The absorption mechanism is investigated, and it is found that at small electron densities the dominant part is played by absorption in the cyclotron resonance region. At densities approaching the critical value (when the plasma frequency approximates to that of the field), the absorption is related to hybrid resonance. Under these conditions the efficiency of the absorption attains 80 to 90%. For electron densities exceeding the critical (plasma frequency larger than that of the microwave field) efficient absorption of the waves is recorded in magnetic fields significantly exceeding the cyclotron field. This absorption is obviously related to the existence in the plasma of a region of resonant increase of refractive index. Experimental results demonstrate the possibility of an efficient absorption by the plasma of microwave energy over a wide range of conditions (densities, magnetic field strengths). Plasmas were investigated obtained by the action of microwave power in open ended magnetic traps with mirror magnetic field configuration. At a power input from some few watts to some tens of kilowatts, in a volume of up to one liter, at a hydrogen pressure from $10^{-5}$ to $10^{-2}$ torr the plasma was obtained with a charged particle concentration from $10^9$ to $10^{14}$ $cm^{-3}$ and an electron temperature up to 150 eV. Electron temperatures up to 10 keV could be attained when applying the microwave power in short pulses. Experiments were started on independent cyclotron heating of the ions in a plasma produced by microwave power. The purpose of these experiments is to obtain a plasma in which the electron and the ion energies can be controlled independently. (auth)

**30562** EXPERIMENTAL AND THEORETICAL STUDIES OF THE TIME AND SPACE DEVELOPMENT OF PLASMA PARAMETERS IN A LASER-INDUCED SPARK IN HELIUM. **Ahmad, N.; Gale, B. C.; Key, M. H. (Queen's Univ., Belfast). Proc. Roy. Soc. (London), Ser. A, 310: 231-52(May 6, 1969).**

An experimental study was made of laser induced breakdown of a gas. 0.2 J of optical frequency radiation was absorbed in helium at 4 atm initial pressure from the focused beam of a Q switched ruby laser. Space and time resolved quantitative data on the plasma development were compared with theoretical models and some new results obtained. Two main experimental techniques were used. Image converter streak photography gave information on the axial and radial growth of the plasma and the time variation of the emission spectrum. Quantitative spectroscopy techniques were used to study the plasma parameters, leading to electron density, temperature and spatial dimensions. Two phases in the plasma evolution are discussed. The first, during which absorption of the incident laser pulse occurs, is characterized by the formation of a radiation driven breakdown wave. The front propagation and the axial dynamic processes behind the front are discussed. New results concerning the structure behind the front and the shape of the front itself are presented. The axial front propagation is consistent with an existing theoretical model. The second phase is a purely thermally driven expansion. A model for the radial development of the plasma in this phase is outlined, based on blast wave theory but including a treatment of ionization. From the experimental evidence, ionization is only of secondary importance in the basic radial expansion. The data suggest a self-similar expansion occurring at a rate consistent with the old blast wave theory but involving radial distributions of parameters departing at the center from those of the old theory. Good agreement was found between experimental data and predictions of this modified blast wave theory concerning the plasma dimensions and electron number density. (auth) (UK)

**30563** SOME PROPERTIES OF THE PLASMAS PRODUCED BY IRRADIATING LIGHT SOLIDS BY LASER PULSES. **Caruso, A.; Gratton, R. (EURATOM–CNEN, Rome). Plasma Phys., 10: 867-77(Sept. 1968).**

A theory is proposed for the processes of irradiation of finite solid targets of light atoms ($H_2$, $D_2$, Li) by giant laser pulses. The properties of the plasma produced are studied and the conditions

to be satisfied in order to obtain an isotropic plasma are given. (auth) (UK)

**30564** SOME RESULTS OF STUDYING ENERGY PARAMETERS OF ELECTRIC-ARC PLASMA INSTALLATIONS. Parkhomenko, A. S. (Leningrad Polytechnic Inst.). Inzh.-Fiz.-Zh., 16: 666-72(Apr. 1969). (In Russian).

Energy characteristics of an electric-arc plasma installation considered as an energy system with a feed source and plasma generator are studied. A diagram of electric parameters is obtained that shows the distribution of electric power from the feed source between individual elements of the circuit and permits operation over a wide variation of the plasma arc. Conditions are found for the maximum value of the power of the plasma jet; parameters for the efficiency of the electric circuit are established. (auth)

**30565** GENERATION OF A FISSIONING PLASMA IN A SHOCK TUBE. Podney, Walter N.; Smith, Harold P. Jr.; Oppenheim, A. K. (Univ. of California, Livermore). Phys. Fluids, 12: Suppl. 1, I.68-72(May 1969).

From 6th International Shock Tube Symposium, Freiburg, Germany. See CONF-670407.

A method of producing a fissioning plasma in a shock tube is proposed. For this purpose a tube is filled with $^{235}UF_6$ gas and one end is embedded in a suitable neutron-reflecting material such as graphite, deuterium, or beryllium. Tube diameter, reflector depth, and initial gas density are chosen so that neutron multiplication within the reflector zone is somewhat less than unity. A shock wave is then introduced into the reflector zone. The additional amount of fissionable material compiled by the wave produces a supercritical mass within the reflector zone; consequently, the fission rate increases rapidly. The subsequent flow field generated by fission-fragment energy deposited in the medium is determined by assuming that the state of the fissioning medium is variable in time but uniform in space. On this basis it is demonstrated that a substantial induction time (~200 msec) is required before the power density is large enough to start expansion of the fissioning substance. For a tube of 10-cm radius with a deuterium reflector extending over a length of 3 m, the estimated energy density produced by a shock of Mach 2 is of the order of 30 kW-sec $cm^{-3}$. The maximum pressure and temperature attained are of the order of 100 atm and 10,000°K. (auth)

**30566** CONTRIBUTIONS OF H. SCHARDIN TO THE THEORY AND APPLICATIONS OF THE SHOCK TUBE. Reichenbach, H. (Ernst-Mach-Institut der Fraunhofer Gesellschaft, Freiburg i. B.). Phys. Fluids, 12: Suppl. 1, I.3-10(May 1969).

From 6th International Shock Tube Symposium, Freiburg, Germany. See CONF-670407.

The theory of the ideal shock tube was first given by Hubert Schardin in 1932 and some of the earliest studies of shock tube performance were then made. These early studies are recalled as well as more recent studies initiated by Schardin on the topic of shock tubes. His other contributions to the physics of rapidly occurring events are also described. (auth)

## *Stability*

**30567** (NP-17881) MAGNETOHYDRODYNAMIC STABILITY OF THE TOROIDAL SCREW PINCH. Rijnhuizen Report 69-52. de Vries, R. F. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Mar. 1969. 48p. Dep.

Plasma is confined by a pulsed helical magnetic field, whose longitudinal and azimuthal components are applied simultaneously. In the region outside the plasma column a dilute plasma is present. During the build-up of the confining field currents are induced in this pressureless plasma which cause the pitch of the magnetic field to be uniform in space and constant in time. Measurements show that this uniform-and-constant-pitch model is much better representation of the experimental situation than the conventional model, where the outside region is vacuum. The observed equilibrium position of the plasma column is in good agreement with the prediction of an existing theory for a toroidal screw pinch surrounded by a uniform-and-constant-pitch magnetic field. The normal-mode stability analysis for a linear screw pinch has been extended by inclusion of toroidal effects. This has been done by adding a periodicity condition to the existing theory. The criteria for stability are then greatly relaxed. In fact, at a series of values for the longitudinal current exceeding the Kruskal–Shafranov limiting current by factors 1.3, 2.4, .... plasmas with a moderately high $\beta$ (~0.2 to 0.3) are stable. These conditions for stability are found to be only weakly dependent on the aspect ratio of the torus. The instabilities observed in the experiments could be explained by these theoretical calculations. The wavelength of the instability could be varied: it was either ⅓ or ½ of the circumference of the torus, depending on the pitch of the applied magnetic field. A correlation was found between the calculated growth time of the instability and the measured confinement time. A method is described to switch two capacitor banks in such a way that the magnetic field in the torus has a fast initial rise followed by a slow rise and a slow decay. A plasma pressure distribution has been derived from detailed magnetic probe measurements along the minor diameter of the torus. (auth)

**30568** (NP-17891) ON THE MARGINAL STABILITY OF LINEARIZED SYSTEMS. Rijnhuizen Report 69-51. Santini, F. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Feb. 1969. 29p. Dep.

The problem of the stability of a perturbed linearized system for modes proportional to $\xi(\vec{r})e^{-i\omega t}$ yields an equation of the form $H(\omega)\xi = 0$. General properties of the operator $H(\omega)$ give information on the stability of the admitted modes. The problem studied here regards conditions for marginal stability (appearance of an unstable solution near one known to exist at some real frequency $\omega$). So far this problem has been studied for equations $H(\omega)\xi = 0$ derivable from a Lagrangian, admitting a regular solution, while $H(\omega)$ is Hermitian for real $\omega$. The main purpose of the present work is to investigate the marginal stability for more general systems including those which admit, in the limit of $\omega$ becoming real, a degenerate eigenvalue $\omega$, singular solutions, or non-Hermitian operators. The latter case frequently occurs in plasma physics where the resonances make the system singular for real $\omega$. Corresponding examples are mentioned. Marginal stability conditions around $\omega = 0$ are worked out for singular systems. Finally, the problem of the marginal stability for an inhomogeneous one-dimensional plasma in equilibrium with an electric field has been introduced. (auth)

**30569** APPROACH TO EQUILIBRIUM OF A ONE-DIMENSIONAL SELF-GRAVITATING GAS. Cohen, Leon (City Univ. of New York); Lecar, Myron. Bull. Astron., 3: 213-25(1968).

A statistical mechanics proposed by Lynden–Bell for systems satisfying the "collisionless Boltzmann" or Vlasov equation is examined. The one-dimensional sheet model is a good testing ground for this theory, for in this model, the potential energy is nonsingular and bounded. Thus phase space is bounded for a given total energy and Lynden–Bell's solutions exist with finite mass. Furthermore, the one-dimensional system is collisionless to first order. Lynden–Bell's prediction of classical degeneracy was confirmed by the analysis presented here. The bulk of the particles was shown to follow Lynden–Bell distribution, but the parameters of this distribution cannot be calculated in advance. (BBB)

**30570** BEHAVIOR OF A Q DEVICE IN THE LOW-DENSITY RANGE. Hashmi, M.; van der Houven van Oordt, A. J.; Wegrowe, J.-G. (Institut fuer Plasmaphysik, Garching, Ger.). Plasma Phys., 10: 861-5(Sept. 1968).

Experimental verification of the "equilibrium" theory in a Q-device was attempted in the low density range by using, apart from probes, resonance fluorescence scattering and microwave methods to measure the density in a singly ionized barium plasma. The results still showed a $\phi \sim n$ dependence, and the particle losses were larger than expected from the theory. The exact nature of these particle losses, however, is not yet known. (auth) (UK)

**30571** ESTIMATE OF A TOROIDAL, MAGNETOHYDRODYNAMICALLY STABLE, HIGH-$\beta$ DYNAMIC EQUILIBRIUM. Wolf, G. H. (Institut fuer Plasmaphysik GmbH, Garching, Ger.); Berge, G. Phys. Rev. Lett., 22: 1096-8(May 26, 1969).

A magnetohydrodynamically stable, toroidal, dynamic equilibrium for a high-$\beta$ plasma can be obtained by superimposing an oscillating bumpy magnetic field upon a purely toroidal static main field. (auth)

**30572** A ONE-DIMENSIONAL, NONLINEAR MODEL OF THE INSTABILITY OF ANISOTROPIC PLASMA. Berezin, Yu. A.; Sagdeev, R. Z. Dokl. Akad. Nauk SSSR, 184: 570-3 (Jan. 21, 1969). (In Russian).

No reliable analytical theories or adequate calculations methods are available to describe the nonlinear state of unstable plasma, with the exception of the one dimensional model. This model makes it possible to follow the development of the instability by computer and to find an analytical solution for it. Such a model of the anisotropic plasma was further studied; this type of plasma is unstable with respect to the growth of the Alfven waves under conditions of $p_{||} > p_{\perp} + H_0^2/4\pi$, whereby $p_{||}(p_{\perp})$ designate the longitudinal (transversal) plasma pressure of the unperturbed magnetic field $H_0$. This problem is important because the instability-generated turbulence probably plays an important role in the processes in the solar wind. The Alfven turbulence may be also

studied on the basis of the hydrodynamic turbulence. In the magnetohydrodynamic equation used, the finite Larmor radius of ions were derived by generalizing the model developed by G. F. Chew, M. L. Goldberger, and F. E. Low. The calculations indicated that averaged magnetic pressure during the period of about 50 inverse instability increments leads to a quasi stationary level which increases with the increasing degree of instability of the plasma. (TTT)

**30573** HYDROMAGNETIC INSTABILITIES IN THE DENSE PLASMA FOCUS. Comisar, G. G. (Aerospace Corp., El Segundo, Calif.). Phys. Fluids, 12: 1000-7(May 1969).

Coaxial discharges of the Mather type owe their performance to the rapid collapse of a noncylindrical current sheath into a dense plasma focus. The lifetime of the resulting fountainlike pinch column appears to be governed by the formation of sausage instabilities; however, typical estimates of the buildup time for m = 0 hydromagnetic instabilities in cylindrical columns are at least 5 to 10 times shorter than the observed lifetimes (~50 nsec). In order to study the effect of pinch curvature a hydromagnetic stability analysis is performed in terms of the Bernstein energy principle expressed in curvilinear coordinates. A necessary stability condition for curved pinches with no axial magnetic fields turns out to be the presence of a delta-function current singularity on the axis, in accordance with hard-core pinch measurements of Colgate. For noncylindrical, axisymmetric pinches of finite curvature and large aspect ratio the m = 0 instability is found to grow about 10 times slower than the corresponding cylindrical pinch case. (auth)

**30574** HIGH-$\beta$ MIRROR INSTABILITIES. Freidberg, J. P. Los Alamos Scientific Lab., N. Mex. United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids, 12: 1112-14(May 1969).

A stability criteria for mirror instabilities in a high-$\beta$ theta pinch is derived by solving the Vlasov equations self-consistently for the equilibrium and perturbation. (auth)

**30575** STABILITY OF A PLANE RELATIVISTIC E LAYER IN A PLASMA WITH IMBEDDED SHEARING MAGNETIC FIELDS. Zien, Hwa M.; Lessen, Martin (Univ. of Rochester, N. Y.). Phys. Fluids, 12: 1036-41(May 1969).

The linear, normal mode instability of a plane relativistic (E-layer) jet is investigated. The surrounding plasma is infinitely conducting, and there are shearing magnetic fields embedded parallel to the plane of the jet and directed perpendicular to the direction of the jet flow. The basic equations are derived from the special theory of relativity. It is found that an increase of the equilibrium energy density of the jet has a stabilizing effect at large disturbance wavenumbers. Increases in the intensity of the shearing magnetic fields and in the jet flow Mach number also have a stabilizing effect at moderate wavenumbers. Unstable, locally supersonic disturbances of outgoing waves relative to the surrounding plasma are found. These radiating waves may be of use in heating the surrounding plasma. (auth)

## Thermonuclear Processes

*Refer also to abstract 30573.*

**30576** (LA-4098) FREE-BOUNDARY SOLUTIONS FOR HIGH-BETA STELLARATORS OF LARGE ASPECT RATIO. Ribe, F. L. (Los Alamos Scientific Lab., N. Mex.). Jan. 1969. Contract W-7405-eng-36. 20p. Dep. CFSTI.

Blank, Grad, and Weitzner recently obtained a solution for the equilibrium of a high-$\beta$ plasma with a sharp boundary in a toroidal Stellarator configuration of slight major curvature. This report summarizes the detailed expansion calculations using their "Scyllac" ordering and presents results in graphs suitable for the design of Scyllac experiments. A new result is presented which gives a nonshifted equilibrium when Stellarator fields of order l and l ± 1 are applied simultaneously. Comparison is made with a previous result of Greene, Johnson, and Weimer, using the "Stellarator" ordering. In this case a critical beta appears, below which the lateral shift of the plasma column is outward for a single l value and above which it is inward, as in the present third-order Scyllac expansion. Curves of critical $\beta$ are given for a sharp-boundaried plasma. The special case of l = 1 and long repetition period $2\pi/h$ of the Stellarator field is of particular interest, since the lateral-displacement instability (m = 1, k = 0) is very weak. Image currents in the wall are effective in this case and can produce stability. The longitudinal current necessary to stabilize the lateral-displacement mode is also calculated for this case. (auth)

**30577** (N-69-20350) PULSED ELECTROMAGNETIC GAS ACCELERATION. Semiannual Progress Report, July 1-December 31, 1968. Jahn, Robert G.; von Jaskowsky, Woldemar F. (Princeton Univ., N. J. Guggenheim Labs. for the Aerospace Propulsion Sciences). Jan. 1969. 130p. (NASA-CR-100386; SAPR-13). CFSTI.

Current sheets propagating in a parallel-plate accelerator are found to arrest their motion at an electrode insulator junction, and there to lapse into stable, quasi-steady discharges. Kerr-cell photography, magnetic and electric probing, and terminal voltage measurements indicate that these stabilized discharges accelerate gas through themselves as long as gas from the prefilling of the discharge chamber is available, after which enhanced erosion of insulator and electrode material appears. The process of energy transfer from a pulse network to a propagating current sheet was studied experimentally and analytically in a linear pinch configuration. The structure of the current sheet in a similar pinch discharge was studied with a specialized high-speed piezoelectric pressure transducer, which determined profiles of both axial and radial pressure. The structure of the anode attachment portion of high-current discharges, and its effect on the overall voltage was studied. Laser techniques were extended to search for population inversions in the outflow plasma from the quasi-steady parallel-plate accelerator. (auth) (STAR)

**30578** ENERGY RELATIONSHIPS AND COEFFICIENT OF ENERGY TRANSFORMATION FOR ELECTRODYNAMIC PLASMA ACCELERATION WITH REGARD FOR MASS TRANSFER PROCESS. Kolesnikov, P. M.; Stolovich, N. N. (Inst. of Heat and Mass Exchange, Minsk). Inzh.-Fiz.-Zh., 16: 659-65(Apr. 1969). (In Russian).

The effects of mass transfer processes due to physical phenomena of recombination, ambipolar diffusion, erosion of electrodes on the energy relationships and coefficient of energy conversion in electrodynamic acceleration of plasma are considered. The effects of resistance forces in various relations with accelerated plasma parameters are discussed. (auth)

**30579** PROCESS FOR THE PRODUCTION OF ENERGY BY CONTROLLED FUSION. Lecomte, Paul. U. S. Patent 3,445,333. May 20, 1969. Priority date Mar. 10, 1964, France.

A process is described for the production of energy by controlled fusion in which a plurality of pairs of separate proton streams are focused and are directed toward a common point in a magnetic bottle, the streams of each pair being opposed to each other and the protons in the streams of each pair moving in helical paths whose circumferential components of movement extend in opposite circumferential directions in order to increase the probabilities of collisions of the atomic nuclei. (auth)

## Wave Phenomena

*Refer also to abstract 30530.*

**30580** (CEA-R-3740) MEASUREMENT OF WAVE NUMBER SPECTRA. Perceval, Francoise (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 1969. 104p. (In French). (EUR-4112). Dep. Thesis.

To measure wave lengths in an ionized medium, the cross correlation product of the signal collected by a fixed probe and that collected by a movable one exploring the medium, is carried out by an interferometer. In order to determine the various modes, a device was built which computes the Fourier transform of the signal. The effects of the phase at the origin, of the damping of the signal, and of the finite explored length have been studied in order to make a numerical calculation of the Fourier transform. (auth)

**30581** (NP-17879) RADIAL OSCILLATIONS OF A MAGNETIZED PLASMA CYLINDER IN PRESSURE EQUILIBRIUM WITH A COLD GAS BLANKET. Rijnhuizen Report 68-49. de Kock, L. C. J. M. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Dec. 1968. 11p. Dep.

A magnetized plasma cylinder in pressure equilibrium with a cold gas blanket oscillates radially with a series of eigenfrequencies starting in the 10 kHz region. It is shown that these low frequencies are not suited to excite magnetoacoustic oscillations, since the amplitude of oscillation is low in the plasma region. Only at certain high frequencies modes of oscillation have been found at which energy can be supplied to the plasma cylinder. (auth)

**30582** RELATIVISTIC NONLINEAR INTERACTION OF COLD PLASMA WITH ELECTROMAGNETIC WAVES. Luenow, W. (Institut fuer Plasmaphysik, Munich). Plasma Phys., 10: 879-97 (Sept. 1968).

The behavior of a fully ionized plasma composed of one type of atom and subjected mainly to electromagnetic forces (waves) is treated analytically. The problem is described by relativistic field equations and equations of motion. The general fundamental equations lead to a special system of equations yielding wave solutions in which all partial waves have the same space-time constant phase velocity. (auth) (UK)

**30583** THEORETICAL AND EXPERIMENTAL STUDY OF WAVE MIXING AND WEAK NONLINEAR RESONANCE PHENOMENA IN A COLD PLASMA COLUMN. Messiaen, A. M.; Vandenplas, P. E. (Ecole Royale Militaire, Brussels). Plasma Phys., 10: 851-9(Sept. 1968).

The general problem of the mixing in a cold plasma cylinder of two incoming waves with $\vec{E}$ perpendicular to the axis of the column is solved to second order. The amplitude of the scattered nonlinear field is computed so that detailed comparison with experiments is possible. In connection with a special case of this general problem, namely the nonlinear scattering of a plane incoming wave by a plasma column, experiments were performed and the three cold plasma resonances observed showed all the characteristics predicted by theory. (auth) (UK)

**30584** REFLECTION AND REFRACTION OF ELECTROMAGNETIC WAVES BY A MOVING UNIAXIALLY ANISOTROPIC SLAB. Kong, Jin-au; Cheng, David K. (Syracuse Univ., N. Y.). J. Appl. Phys., 40: 2206-12(Apr. 1969).

The reflection, refraction, and transmission characteristics of a plane electromagnetic wave incident from an isotropic medium, through a moving uniaxial slab, and into another isotropic medium are studied. The conceptual equivalence of a moving medium and a stationary anisotropic one with suitable defined permittivity and permeability tensors is used for the analysis. Complete field expressions are obtained in all three regions for an arbitrary orientation of the plane of incidence and an arbitrary angle of incidence. Special cases where the plane of incidence is parallel, or perpendicular, to the direction of slab motion are considered for both an incident E wave and an incident H wave. Some interesting numerical results are presented for the transmission coefficient at normal incidence when the moving slab is a magnetonionic plasma subject to a strong magnetic field and when the moving slab is a uniaxial crystal. (auth)

**30585** THE NUMERICAL SOLUTION OF A VOLTERRA INTEGRAL EQUATION. Kent, Gordon; Mautz, Joseph (Syracuse Univ., N. Y.). J. Comput. Phys., 3: 399-415(Feb. 1969).

A method is presented for the numerical solution of the Volterra integral equation which describes signal propagation on an electron beam or electrostatic oscillations of a temperature plasma. The method is based on a step function approximation of the velocity distribution function, an approximation suitable for direct inclusion of experimental data, and Laplace transform analysis is used to obtain a solution expressed as an almost periodic function. Results of computation are presented for an example typical of the electron beam problem. It is shown that for a specified maximum error the order of the approximation of the distribution function is a linearly increasing function of the maximum value of the independent variable. (auth)

**30586** PHASE EFFECTS IN THE NONLINEAR INTERACTION OF "NEGATIVE"-ENERGY WAVES. Engelmann, F.; Wilhelmsson, H. (EURATOM—CNEN, Rome). Z. Naturforsch., 24a: 206-7 (Feb. 1969).

Nonlinear interaction of "negative"-energy waves is studied assuming well-defined phases and perfect matching conditions. The results are compared with those of the random-phase approach, and significant differences in the dynamics due to phase effects are pointed out. (auth)

**30587** MULTIPLE SCATTERING OF ELECTROMAGNETIC WAVES IN AN UNDERDENSE PLASMA. Watson, Kenneth M. (Univ. of California, La Jolla). J. Math. Phys. (N. Y.), 10: 688-702(Apr. 1969).

Scattering of electromagnetic waves by an extended underdense plasma is studied. The analysis begins with expressions for multiple scattering of waves. An explicit account of coherent scatterings leads to modified equations. These modified equations are used to derive a transport equation for the intensity (a tensor expressed in polarization components). It is shown that this transport equation may be applied to the calculation of radar backscatter. (auth)

**30588** EXPERIMENTAL AND THEORETICAL EIGENMODES OF A SPHERICAL CAVITY PARTIALLY FILLED WITH PLASMA. Boyen, H. L.; Messiaen, A. M.; Vandenplas, P. E. (Ecole Royale Militaire, Brussels). J. Appl. Phys., 40: 2296-2305(Apr. 1969).

A complete experimental and theoretical account is given of the eigenmodes (cold and hot) which exist at low power in a cavity partially filled with a plasma. The cavity modes which are perturbed by the plasma together with the basic cold-plasma modes are studied theoretically using uniform cold-plasma theory. The hot-plasma modes of the system are investigated on the basis of a WKB approximation of the relevant equations of a nonuniform hot plasma. Experiments performed with a spherical discharge tube and also with a spherical afterglow plasma give results which are in satisfactory agreement with theoretical predictions. The measured Q factor of the resonances also agrees with theoretical calculations. (auth)

**30589** METHOD FOR SOLVING THE DISPERSION EQUATION OF ELECTRON PLASMA. Stainov, G. Z. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 22: 133-6(1969).

A method is proposed for solution of the linearized dispersion equation for oscillations of the type $e^{j(\omega t - kx)}$ in an infinite, homogeneous, and isotropic electron plasma, free from outer fields and in which the ions are considered to be immobile. (M.O.W.)

**30590** MICROWAVE SCATTERING AND NOISE EMISSION FROM AFTERGLOW PLASMAS IN A MAGNETIC FIELD. Blum, F. A.; Bauer, L. O.; Gould, R. W.; Stenzel, R. L. (California Inst. of Tech., Pasadena). Phys. Fluids, 12: 1018-27(May 1969).

The microwave reflection and noise emission (extraordinary mode) from cylindrical rare-gas (He, Ne, Ar) afterglow plasmas in an axial magnetic field is described. Reflection and noise emission are measured as a function of magnetic field near electron cyclotron resonance ($\omega \approx \omega_c$) with electron density as a parameter ($\omega_p < \omega$). A broad peak, which shifts to lower values of $\omega_c/\omega$ as electron density increases, is observed for $(\omega_c/\omega) \leq 1$. For all values of electron density a second sharp peak is found very close to cyclotron resonance in reflection measurements. This peak does not occur in the emission data. Calculations of reflection and emission using a theoretical model consisting of a one-dimensional, cold plasma slab with nonuniform electron density yield results in qualitative agreement with the observations. Both the experimental and theoretical results suggest that the broad, density-dependent peak involves resonance effects at the upper hybrid frequency ($\omega_h^2 = \omega_c^2 + \omega_p^2$) of the plasma. (auth)

**30591** ELECTROMAGNETIC RADIATION OF MAGNETIC-FIELD-FREE ELECTRON PLASMA WAVES FOR ISOTROPIC AND ANISOTROPIC GAS PRESSURES. Bessenrodt, R. (Technische Hochschule, Hanover). Z. Naturforsch., 24a: 311-18 (Mar. 1969). (In German).

In previous studies the electromagnetic radiation resulting from nonlinear self-interaction of electron plasma waves was treated by taking the electron pressure to be isotropic. Here the radiation flux is determined in the far field of the disturbance for the anisotropic case, too. By assuming statistical homogeneity in space and time and accounting only for pair correlations of the particle density the mean flux near the second harmonic of the plasma frequency can be expressed by the energy spectrum of the primary waves. As an application, approximate formulas for coronal conditions (type II and III bursts are found. The anisotropy corrections are of the order $(a/c)^2$ (a = electron sound velocity, c = velocity of light). (auth)

**30592** WAVES IN COLLISIONLESS PLASMAS. III. TRANSVERSE WAVES IN A HOT, MAGNETIZED PLASMA. Levin, Joel M. (Drexel Inst. of Tech., Philadelphia). Phys. Fluids, 12: 1069-71(May 1969).

The problem of the propagation of transverse waves parallel to a fixed magnetic field in an infinite, hot, collisionless plasma is treated by using the exact solution of the Vlasov equation to express the electron currents in terms of the fields. Maxwell's inhomogeneous equations are then expressed as an integrodifferential equation purely in terms of the electric field E (z,t). This equation is solved in terms of Green's functions which map the initial fields into the electric field E (z,t) for all $0 < t < \infty$ The effects of the induced magnetic fields on the particle trajectories are ignored, but no other approximations are made. (auth)

**30593** OBSERVATION OF ION CYCLOTRON WAVES IN A HOT PLASMA. Uman, Myron F.; Hooke, William M. (Princeton Univ., N. J.). Phys. Fluids, 12: 1072-80(May 1969).

According to the theory of the propagation and absorption of ion cyclotron waves in a hot magnetized plasma, the wavelength approaches a minimum, nonzero value as the wave propagates into a magnetic beach where the wave frequency approaches the local ion cyclotron frequency. Furthermore, the damping of the waves is a sharply resonant function of the magnetic field strength, the width of the resonance being proportional to the square root of the ion temperature for motion parallel to the static magnetic field. These effects are observed in a plasma confined in a linear magnetic mirror geometry for perpendicular ion temperatures in the range 10 to 110 eV. The wave fields are measured with two mag-

netic probes, the plasma density is measured with two microwave interferometers, and the perpendicular ion temperature is measured with a diamagnetic probe. The theory is developed for the transport of spatially damped waves in a hot, finite plasma immersed in a slightly inhomogeneous magnetic field. Quantitative agreement between theory and experiment is obtained. These measurements represent the first experimental observations of thermally broadened collisionless cyclotron absorption in a laboratory plasma. Observations of collisional damping of ion cyclotron waves are also presented. (auth)

**30594** COLLISION DAMPING OF LONGITUDINAL PLASMA WAVES. Matsuda, Kyoko (Goddard Space Flight Center, Greenbelt, Md.). Phys. Fluids, 12: 1081-3(May 1969).

The dispersion relation including collision effects has been obtained by Rostoker's test-particle method. The damping factor is calculated for the case of large wavelength. The result presents a correction to the previous calculations by other authors. (auth)

**30595** COLLISIONAL DAMPING OF WAVES IN A SLIGHTLY RELATIVISTIC PLASMA. McBride, John B. (Dartmouth Coll., Hanover, N. H.). Phys. Fluids, 12: 1084-8(May 1969).

The dispersion and collisional damping of small-amplitude electron waves in a plasma are calculated to first order in the collisions treating the electrons relativistically. The treatment is to lowest order in the relativistic corrections. The Belyaev–Budker equation to order $(p/mc)^2$ is used, and the dispersion calculated using an approximate solution to evaluate the electron current density. For no external fields, the longitudinal plasma oscillation, and transverse electromagnetic mode are treated. For a uniform magnetic field, the longitudinal plasma oscillation, the linearly polarized, and circularly polarized modes are treated. At higher temperatures the over-all damping decreases. In the longitudinal mode, the relativistic correction term increases the damping. In the linearly polarized transverse modes, the relativistic correction increases (decreases) the damping for $\omega_p^2 > 3c^2k^2 (\omega_p^2 < 3c^2k^2)$. The relativistic correction to the collisional part of the current in all the modes is due to electron–ion collisions, and in all but the circularly polarized modes results from the relativistic normalization constant of the equilibrium electron distribution function. (auth)

**30596** EXPERIMENTAL VERIFICATION OF ELECTRON CYCLOTRON DAMPING IN A PLASMA WITH COLLISIONAL LOSSES. Minami, Kazuo; Takeda, Susumu (Nagoya Univ., Japan). Phys. Fluids, 12: 1089-97(May 1969).

The right-hand circularly polarized microwave (R wave) propagating along a magnetic field in a plasma is described by the hot-plasma theory near the electron cyclotron resonance where the thermal effect of the electron should be taken into account. The left-hand circularly polarized wave (L wave), which has no resonance, is described by the cold-plasma theory. The plasma parameters such as the electron densities and the collision frequencies are measured by the reflection coefficient of the L wave at the plasma boundary. The attenuation constant $\alpha_c$ of the R wave is then calculated by the cold-plasma theory from the plasma parameters thus obtained; $\alpha_c$ is compared with the attenuation constant $\alpha_h$, measured directly by the R wave. The measurements are performed during the decaying period of the plasma produced in a circular waveguide filled with argon at a pressure of 0.1 torr. The electron temperature $T_e$ deduced from $\alpha_h/\alpha_c$ is compared with $T_e$ independently measured by a double probe. The experimental results of $\alpha_h/\alpha_c$ indicate a reasonable enhancement of the attenuation of the R wave near the electron cyclotron resonance. (auth)

**30597** PARAMETRIC EXCITATION OF DRIFT WAVES IN A RESISTIVE PLASMA. Weyl, Guy; Goldman, Martin (Univ. of California, Los Angeles). Phys. Fluids, 12: 1097-1109(May 1969).

The parametric excitation of drift waves in an inhomogeneous resistive plasma is derived from the fluid equations. In the particular case studied, the plasma is pumped by a drift wave at $\omega_0$ and responds at a frequency $\omega_1 = \frac{1}{2}\omega_0$. Plane geometry is assumed throughout this paper but periodic boundary conditions in z (direction of the uniform magnetic field) and in y (azimuthal direction) are assumed, to simulate experimental conditions with cylindrical or toroidal geometry. The resulting discrete spectrum of drift waves is assumed stabilized by end plate effects (for lower-frequency modes) or by ion–ion collisions (at higher frequencies). The threshold amplitude for parametric excitation is calculated and the enhancement of fluctuations below threshold leading to enhanced particle diffusion toward regions of decreasing density is calculated. The possibility of measuring the enhanced fluctuation spectrum by microwave scattering experiments is also studied. (auth)

**30598** AMPLITUDE DISPERSION AND NONLINEAR INSTABILITY OF WHISTLERS. Tam, Christopher K. W. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 12: 1028-35(May 1969).

The propagation of small- but finite-amplitude plane "whistlers" in a cold plasma imbedded in a uniform magnetic field is studied. The usual frequency dispersion relation of linear theory is extended to include the effect of amplitude dispersion. The present analysis is based on a perturbation procedure in which the frequency, wavenumber, and amplitude relation is represented by a power series in the energy density or the square of the amplitude of the wave. It is found that the effect of amplitude dispersion is to cause the "whistlers" to undergo nonlinear instability if the wave vector k is not parallel to the direction of the undisturbed magnetic field. For plane whistlers which propagate along the mean magnetic field lines it is noted that the linear solution is also an exact solution of the two component cold plasma equations. (auth)

# Shielding

*Refer also to abstracts 29173, 30111, 30887, and 30888.*

**30599** (AD-674610) THE SPM (STOCHASTIC PROCESS METHOD) EQUATION FOR CALCULATING THE SPATIAL VARIATION OF NEUTRON SPECTRA. Report for May 1959–May 1960. Klahr, Carl N.; Zell, H. Julius (TRG, Inc., Syosset, N. Y.). Sept. 1960. Contract AF33(616)-5187. 159p. (WADD-TR-60-312). CFSTI.

The SPM equation is a second order partial differential equation in lethargy (or energy) and spatial coordinates. It promises to describe the slowing down and spatial diffusion of neutrons with sufficient accuracy for shielding problems and for other applications where neutron flux spectra are critical. A primitive SPM with infinite orders of derivatives is first obtained from either the Smoluchowski or Boltzmann equations. It is then truncated after the second order derivatives. The coefficients of two forms of this equation are obtained and suitable boundary conditions are given. A code has been written to solve this equation on the 1103A Univac. Various solutions are given. (auth)

**30600** (AD-837087) DOSE MEASUREMENTS OF GAMMA RADIATION STREAMING THROUGH CONCRETE DUCTS WITH AND WITHOUT LEAD LINERS AND THROUGH CORRUGATED STEEL DUCTS. Final Report, August–December 1967. Chapman, J. M.; Tree, T. R. (Naval Civil Engineering Lab., Port Hueneme, Calif.). June 1968. 21p. (NCEL-TR-590). CFSTI.

Dosimeter measurements were taken in a 3-foot-square, two-legged concrete duct, with and without the presence of lead sheets covering the basic scattering areas in the corner, to determine the effectiveness of lead sheeting in reducing gamma radiation. For $^{60}Co$ radiation, the lead sheets reduced the dose rate in the second leg of the duct down to 46% of the dose rate measured in the second leg of the duct without lead sheets, and for $^{137}Cs$ radiation the reduction was down to 36%. Calculations were made to determine the effectiveness of the sheets in different size ducts, and comparisons were made with other methods for reducing radiation. Measured attenuation factors for a circular, thin-walled, corrugated steel duct were compared to values calculated by a simple computer program for a square, thick-walled steel duct. It appears that the computer code can be used to approximate attenuation factors for a corrugated steel duct. (auth)

**30601** (N-69-15375) TRANSPORT STUDY OF NEUTRON AND PHOTON ATTENUATION THROUGH LITHIUM HYDRIDE AND TUNGSTEN SPHERICAL MEDIA. Peoples, John A.; Fieno, Daniel (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan. 1969. 33p. (NASA-TN-D-4989). CFSTI.

The $S_n$ transport theory and a point kernel method were used to study the attenuation of point fission neutrons in LiH and $Li^6H$, point 8.00-MeV photons in tungsten, and neutrons and secondary protons from a fast reactor through a laminated W/$Li^6H$ shield. The results show that the two methods calculate in agreement neutron and photon doses through these media provided (1) at least a $P_3S_{16}$ transport calculation is used, and (2) for neutron attenuation, the point kernel method uses a distributed neutron removal cross section for Li and $^6Li$ of 0.1000 $cm^2/g$ and 0.1156 $cm^2/g$. Secondary photon source strength and distributions in the tungsten shells of the laminated tungsten/$^6$LiH shield were also determined using a $P_3S_{16}$ transport calculation. (auth)

**30602** (N-69-20854) OPEX 2: A RADIATION SHIELD OPTIMIZATION CODE. Lahti, Gerald P. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1969. 26p. (NASA-TM-X-1769). CFSTI.

A radiation shield optimization procedure based on the computer code, OPEX-II, is described. The OPEX-II code, based on an earlier, steepest-descent-method code OPEX, has been recoded to improve coding, simplify data input, use spherical geometry, and alter the dose-thickness relation when a layer has been removed. A complete description of how to obtain the necessary input data for OPEX-II from other transport calculations is given. Data input instructions, FORTRAN IV code listing, and a sample problem optimizing a seven-layer shield of tungsten and lithium hydride for a space power reactor are given. (auth) (STAR)

**30603** (ORNL-RSIC-25) SHIELDING BENCHMARK PROBLEMS. Profio, A. E. (ed.) (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 109p. (ANS-SD-9). Dep. CFSTI.

The Benchmark Problems Group of the American Nuclear Society Shielding Standards Subcommittee (ANS-6) has selected several "benchmark" problems for testing computational methods of radiation transport. The first four problems are described and solution data are presented. These problems are: fast neutron spectrum from a point fission source in infinite graphite, gamma-ray spectrum from a point $^{137}Cs$ source in infinite water, neutron spectrum from point fission and 14-MeV sources in infinite air, and gamma-ray dose above a plane source of $^{60}Co$ on an air/ground interface. (M.H.R.)

**30604** (ORNL-TM-2499) SOME CALCULATED MILESTONE SOLUTIONS TO TIME-DEPENDENT RADIATION TRANSPORT PROBLEMS. Straker, E. A.; Engle, W. W. Jr.; Stevens, P. N. (Oak Ridge National Lab., Tenn.). Apr. 22, 1969. 37p. Dep. CFSTI.

In developing time-dependent transport computer codes it is helpful to have some typical problems for which the answers are believed to be known. Thus reproducibility of these results provides confidence in the use of new techniques. Some time-dependent results are presented for three problems: (1) one-speed isotropic scatterer with nonabsorption probabilities of 0.3 and 0.9; (2) a point 12.2- to 15-MeV neutron source in infinite homogenous air; and (3) a point fission neutron source in infinite homogenous air. Both Monte Carlo and discrete ordinates techniques were used in determining time-dependent results at 3, 6, and 9 mean free paths for problem 1 and at 300, 600, and 900 meters for problems 2 and 3. (auth)

**30605** (UCRL-18801) EVALUATION OF SCATTERED DOSE RATE BY SINGLE COMPTON SCATTERING. Rising, Donald L. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 6, 1969. Contract W-7405-eng-48. 15p. Dep. CFSTI.

A method of calculating the photon flux and dose rate from scattered gamma rays, based on single Compton scattering theory, is presented. This method is more limited in application than the use of Monte Carlo programs, but is simpler and requires less computing time. It is particularly suited to the scattering of medium-energy $\gamma$ rays by air in irradiators using $^{60}Co$ or other isotopes. The calculations show that the solutions are volume integrals over the scattering medium which can be evaluated by numerical integration. An example of a particular irradiator is given, together with the program used to evaluate the integrals and some typical input and output. (auth)

**30606** HIGH-ENERGY (<18 GeV) MUON TRANSPORT CALCULATIONS AND COMPARISON WITH EXPERIMENT. Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.); Barish, J. Nucl. Instrum. Methods, 71: 121-4(1969).

Calculations of the transport of high-energy photomuons through a very thick iron shield have been carried out. Results have been obtained using both Monte Carlo methods and the semi-analytic theory of Eyges. The data obtained by these two different methods of calculation are in very good agreement, but they do not agree well with the experimental data. (auth)

**30607** A NUMERICAL TREATMENT OF THE ATTENUATION OF NEUTRONS BY AIR DUCTS IN SHIELDS. Artigas, Ricardo (Battelle Memorial Inst., Columbus, Ohio); Hungerford, H. E. Nucl. Sci. Eng., 36: 295-303(June 1969).

Expressions for the neutron flux at the exit of a cylindrical duct of radius $\delta$ and length l (with $\lambda = \delta^2/l^2$), have been found by the use of the albedo concept and by the method of single-collision sources in the duct wall, based on monoenergetic integral transport theory. In contrast with other methods of solution, the isotropic area source of radius $\delta$ at the duct entrance is not approximated by a point source, and the numerical evaluation of integrals does not impose restrictions on the values of $\lambda$. Calculation of the neutron flux at the duct exit is expedited by the use of the tables given, which are a function of the duct geometry and were generated from the numerical evaluation of the integrals that appear in the expressions for the flux. Comparison of the results as predicted by the formulas developed here and those predicted by already existing formulas with the results of a stochastic neutron-transport code indicates that the formulas developed here are always in better agreement with the results of the code. For values of $\lambda < 1$, the formulas developed here differ by a maximum of $\pm 10\%$, while the existing formulas differ by a maximum of more than 100%. (auth)

**30608** ON RAFALSKI'S SOLUTION TO THE ALBEDO PROBLEM. Pomraning, G. C. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng., 36: 457(June 1969).

Rafalski [Nucl. Sci. Eng., 19: 378(1964)] has considered the monoenergetic transport problem of computing the probability that a neutron will be reflected if it is perpendicularly incident upon a semi-infinite halfspace. It is pointed out here that Rafalski's approximate solution to the normal beam albedo problem is, in fact, an exact transport solution to the albedo problem for another simple incident distribution. This observation leads to an explanation as to why Rafalski's results are most accurate for highly absorbing systems. (M.H.R.)

**30609** EXPERIMENTAL STUDIES OF FAST NEUTRON SHIELDING. Sauermann, P. F.; Schaefer, W. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik, 11: 197-203(Apr. 1969). (In German and English).

Experiments are reported aimed at demonstrating whether the dose rate attenuation coefficients serving to calculate the required thickness of concrete shielding can be determined by measurements carried out on heaped individual ingredients of the concrete concerned. The experimental conditions required for this purpose were determined in preliminary experiments. The attenuation coefficients of ordinary concrete and of limonite concrete were calculated from the mass dose rate attenuation coefficients of the individual components of these concretes and were compared with values measured directly on concrete slabs. The agreement is good. Tables are given showing attenuation factors computed for a range of thickness, and the use of these tables is illustrated on a practical example. (auth)

**30610** SHIELDING OF 15 MeV NEUTRONS. Hacke, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Kerntechnik, 11: 193-6(Apr. 1969). (In German and English).

The shielding possibilities for 15-MeV neutrons are discussed, starting from the fact that, with small accelerators, it is possible to obtain high neutron source strengths in this energy range. It is shown how the neutron equivalent dose rate can be calculated using the technical data of the accelerator. The attenuation in normal concrete is discussed. Values for the attenuation coefficient of normal concrete found theoretically or experimentally by different authors are compared. Finally, the construction of shielding and methods of shielding measurements are described briefly. (auth)

**30611** SOLUTION OF THE EQUATION OF TRANSPORT BY THE METHOD OF MOMENTS. Nurdin, G. (Laboratoire Central de l'Armement, Arcueil, France). Radioprotection, 3: 241-59 (1968). (In French).

The physical hypotheses on which this study, limited to $\gamma$ radiation, are based are reviewed. The introduction of dimensionless magnitudes makes it possible to reduce an inhomogeneous medium to a homogeneous medium. The case of a stationary source is then considered as being a particular case of a Dirac source. The method of moments is then generalized. This is a classical and profitable method for the stationary case with the reserve that the propagation medium be semi-infinite and the penetration distances do not exceed 15 mean free path lengths. (tr-auth)

## Solid-State Physics

*Refer also to abstracts 30296, 30722, 30933, and 30996.*

**30612** (ORNL-4408) SOLID STATE DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1968. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 117p. Dep. CFSTI.

AMMONIUM CHLORIDES—phonon dispersion measurements using coherent inelastic neutron scattering
ATOMIC BEAMS—scattering in solids, Firsov inversion of cross sections for, (T)
CADMIUM—radiation damage in, recovery of neutron
CERIUM OXIDES—europium-ion ESR spectra in irradiated crystals of
COPPER—radiation damage at high temperatures in crystals of, fast-neutron and proton
—radioinduced defects in single crystals of, electron micro-

scopic studies of fast-neutron
—elastic nonlinearity parameters of single crystals of, temperature dependence of
—dislocation pinning in irradiated crystal of
—x-ray diffraction properties of crystals of, effects of dislocations on
—radioinduced defects in crystals of, x-ray diffuse scattering produced by fast-neutron
—x-ray absorption coefficient in, temperature dependence of linear
—use in pressure welding of lunar specimen containers
CRYSTALS—elastic displacement in anisotropic cubic, Green's function for, (T)
CYANIDES—phonon resonant absorption by, in potassium chloride
DUNITES—electron spin resonance of manganese and iron ions in, effects of heat treatments on
ELECTRONS—effects on graphite, defect clusters produced in
—effects on doped germanium
EUROPIUM IONS—electron spin resonance spectra in irradiated ceria and thoria
FEEDBACK SYSTEMS—development of transistorized network, with extended measurement range
GADOLINIUM ISOTOPES Gd-160—phonon dispersion measurements
GALLIUM—phonon dispersion measurements
GERMANIUM—radioinduced defects in antimony- and arsenic-doped, annealing of electron
—growth of single crystals of, in vacuum and hydrogen for detector use
GRAPHITE—radioinduced defect clusters in, electron
HAFNIUM SILICATES—growth of doped single crystals of
HOLMIUM—phonon dispersion measurements
INDIUM—phonon dispersion measurements
INFORMATION CENTERS—activities of Research Materials
ION BEAMS—channeling of, electronic stopping in, (T)
IRON—radiation-anneal hardening in, effects of nitrogen on fast-neutron
IRON IONS—electron spin resonance spectra in silicate minerals
LEAD IONS—electron spin resonance spectra in irradiated thoria crystals
LEAD SULFIDES—growth of single crystals of, hydrothermal
LITHIUM—phonon spectra
LITHIUM FLUORIDES—U centers in isotopic, calculation of local mode frequency of
LITHIUM IODIDES—thermal capacity at low temperatures, analysis of
LITHIUM ISOTOPES Li-6—phonon resonant absorption by, in potassium chloride
MAGNESIUM OXIDES—luminescence in irradiated and additively colored crystals of
—preparation of large clear crystals of pure, developments in
MAGNETIC MATERIALS—properties and structure of, research program on
MANGANESE IONS—electron paramagnetic resonance in zinc chloride, effects of proton-induced glassy state on
—electron spin resonance spectra in silicate minerals
METALS—radiation damage in pure, recovery of neutron
METEORITES—electron spin resonance of manganese and iron ions in, effects of heat treatments on
NEPTUNIUM OXIDES—growth of $NpO_2$ single crystals
NEUTRONS—effects on niobium, effects of interstitial impurities on annealing of
—effects on cadmium, annealing recovery of
—effects on pure metals, annealing recovery of
NEUTRONS, FAST—effects on vanadium, trapping of oxygen at defects produced in
—effects on copper crystals
—effects on mechanical properties of A-533B Class 1 steel plate
—effects on yield stresses of iron and niobium
—effects on x-ray diffuse scattering in copper crystals
NIOBIUM—magnetic flux pinning at radioinduced defects in superconducting
—annealing of neutron-irradiated, effects of interstitial impurities on
—radiation-anneal hardening in, studies of defect clusters in fast-neutron
—impurity distribution in electron-beam-zone-refined, autoradiography of tantalum and tungsten
NIOBIUM ALLOYS & SYSTEMS—Nb-base-Zr, magnetic flux pinning at radioinduced defects in superconducting
NITROGEN—effects on radiation-anneal hardening in iron
OLIVINES—electron spin resonance of manganese and iron ions in, effects of heat treatments on
PHONONS—spectra and dispersion curves in solids
—resonant absorption in lithium-6- and cyanide-doped potassium chloride
POTASSIUM CHLORIDES—phonon resonant absorption in lithium-6- and cyanide-doped
—radioinduced F centers in, interstitial-trapping model of
POTASSIUM COPPER CHLORIDES—thermal conductivity of $CuK_2Cl_4 \cdot 2H_2O$ in magnetic fields near Curie point
POTASSIUM HALIDES—F centers in, calculation of F and K band shapes for
PROTONS—effects on copper crystals
RUTILES—lattice normal-mode frequencies in, inelastic neutron scattering study
SILICATE ROCKS—electron spin resonance of manganese and iron ions in, effects of heat treatments on
SILVER—preparation of perfect single crystals of
SILVER CHLORIDES—thermal capacity at low temperatures, analysis of
STEEL—radiation effects on mechanical properties of A-533B Class 1, fast-neutron
—mechanical properties of 12-inch plate of A-533B Class 1, thickness and orientation dependences
SUPERCONDUCTORS—magnetic flux pinning at radioinduced defects in niobium and its alloy with zirconium
TANTALUM—distribution in zone-refined niobium, autoradiographic measurements
TERBIUM—phonon dispersion measurements
THORIUM OXIDES $ThO_2$—electron spin resonance spectra of lead and europium ions in irradiated crystals of
THORIUM SILICATES—growth of doped single crystals of
TIN—phonon dispersion measurements on gray
TUNGSTEN—distribution in zone-refined niobium, autoradiographic measurements
URANIUM OXIDES $UO_2$—growth of single crystals of
VACUUM VESSELS—sealing of lunar specimen containers by pressure welding
VAN DE GRAAFF ACCELERATORS—operation of ORNL 2-MeV
VANADIUM—annealing of fast-neutron-irradiated, trapping of oxygen at radioinduced defects during
X RADIATION—absorption coefficient in copper, temperature dependence of linear
X-RAY-DIFFRACTION ANALYSIS—diffuse scattering by defects in crystals
ZINC CHLORIDES—manganese-ion EPR in crystals of, effects of proton-induced glassy state on
ZINC OXIDES—ion channeling measurements of zinc interstitials in additively colored single crystals of
ZIRCONIUM ALLOYS & SYSTEMS—Ng-base-Zr, magnetic flux pinning at radioinduced defects in superconducting
ZIRCONIUM SILICATES—growth of doped single crystals of (D.L.C.)

**30613** PROCEEDINGS OF THE FOURTEENTH ANNUAL CONFERENCE ON MAGNETISM, NEW YORK, N. Y., NOVEMBER 18–21, 1968. J. Appl. Phys., 40: 915–1608(Mar. 1, 1969). (CONF-681121).

A total of about 320 papers, 75 of which are abstracts only, are included. Some of the topics covered are: transport phenomena, thin films, insulators, rare earths and their alloys and compounds, chalcogenide spinels, phase transitions, bioengineering, exchange-enhanced metals and local moments, domains, ferromagnets and antiferromagnets, magnetic structures, magnetoelastic and magnetostatic waves, resonance and magneto-optic effects, critical phenomena, band structure and correlation effects, NMR and Moessbauer effect, transition metals and their alloys and compounds, pressure and optical effects, microwave materials, neutron scattering, memory materials, magnetoresistance and Kondo effect, garnets, soft and hard magnetic materials, microwave resonance, anisotropy and thermal conductivity, band calculations and spin structures, and trifluorides. Twenty-seven of the papers were abstracted for NSA. (D.L.C.)

*For abstracts of individual papers see: 30045–30047, 30175, 30176, 30191, 30642–30656, and 30667–30672.*

## Radiation Effects

**30614** (COO-1800-1) STUDY OF POINT DEFECTS BY MEANS OF DISLOCATION PINNING EFFECTS. Sosin, A. (Utah Univ., Salt Lake City). Dec. 15, 1968. Contract AT(11-1)-1800. 15p. (CONF-680954-1). Dep. CFSTI.

From International Conference on Point Defects, Juelich, Germany.

A discussion is presented of the problems in the study of the point defect–dislocation interaction in dislocation pinning in

metals. After a description of the vibrating-string model, the results of some irradiation-annealing studies in copper and gold are examined. The nature of dislocation pinning is discussed, and it is concluded that the point defect–dislocation interaction is complex and that there is no theory adequate for interpretation of the data. (D.L.C.)

**30615** (N-68-19955) DEFECT PRODUCTION IN SINGLE CRYSTAL RESULTING FROM ION BOMBARDMENT. Semiannual Status Report, July 1–December 31, 1967. Shaffer, Lawrence B. (Hiram Coll., Ohio. X-Ray Physics Lab.). Jan. 31, 1968. 7p. (NASA-CR-93768; SASR-3). CFSTI.

Summary information is provided on the reassembly of the double-crystal x-ray spectrometer, and on the problems encountered in installing the vacuum system. It is also reported that a theoretical evaluation of the ion–surface interaction was initiated, along with a study on the interpretation of the x-ray data to be obtained. (STAR)

**30616** (N-68-35787) DEFECT PRODUCTION IN SINGLE CRYSTALS RESULTING FROM ION BOMBARDMENT. Semiannual Status Report, January 1–June 30, 1968. Shaffer, Lawrence B. (Hiram Coll., Ohio. X-Ray Physics Lab.). Aug. 9, 1968. 25p. (NASA-CR-97070; SASR-4). CFSTI.

Damage produced on the surface of metal single crystals during ion bombardment using x-ray methods was studied, and certain thermodynamic properties of cesium gas were determined using x-ray methods. An ultrahigh vacuum system and ion gun apparatus are described. Cesium gas scattering investigations presented difficulties in cell design and adequately filling the tubes. Design and modification, detection electronics, and the high-voltage power supply were considered for the double-crystal x-ray spectrometer, for which the experimental procedure, computer analysis of data, and x-ray topographs are reviewed. (STAR)

**30617** (N-69-22552) ANNEALING OF 22-, 40-, AND 158-MeV PROTON DAMAGE IN n- AND p-TYPE SILICON. Beatty III, Marvin E.; Hill, Gerald F. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Apr. 1969. 26p. (NASA-TN-D-5119). CFSTI.

Studies on n- and p-type silicon irradiated with 22-, 40-, and 158-MeV protons and annealed at 100°C, 200°C, and 300°C are reported. A fluence dependence was found for protons in which the annealing decreased as the fluence increased and was compared with results previously reported for electrons. Alternate increases and decreases in minority-carrier lifetime during isothermal annealing is discussed. (auth) (STAR)

**30618** (NYO-3681-3) EFFECTS OF RADIATION OF ALKALI AZIDES USING ELECTRON SPIN RESONANCE TECHNIQUES. Final Report. Wylie, Douglas W. (Maine Univ., Orono). Mar. 31, 1969. Contract AT(30-1)-3681. 8p. Dep. CFSTI.

A description is given of the ESR x-band superheterodyne spectrometer and its operation. $RbN_3$ single crystals were irradiated with x rays, ultraviolet rays, and gamma rays at 77°K and their ESR spectra examined before and after warming to 300°K. The results indicate that the paramagnetic center NO is formed by x irradiation and $N_4^-$ is formed by $\mu$v irradiation; no ESR spectra resulted from the gamma irradiation. The structure of $NaN_3$ is discussed. (D.L.C.)

**30619** (ORO-3098-12) PROGRESS REPORT [ON RADIATION EFFECTS IN CRYSTALLINE MATERIALS], APRIL 1969. Chaplin, R. L. (Clemson Univ., S. C. Dept. of Physics). Contract AT(40-1)-3098. 13p. Dep. CFSTI.

Research was continued on the effects of 0.40-MeV electrons and their annealing in polycrystalline Al, high-purity Mg, and the metals Cu, Ti, and V. The dose dependence of the Stage I annealing of Al was studied. The annealing stages of polycrystalline Mg were examined, and experiments are in progress on Mg single crystals. Interpretations are presented from the annealing spectrum of high-purity Cu. Preliminary results are given for Ti. (D.L.C.)

**30620** VISUALIZATION OF COLOR CENTERS IN ALKALI METAL HALIDE CRYSTALS. Distler, G. I.; Lebedeva, V. N.; Moskvin, V. V. (Inst. for Crystallography, Moscow). Sov. Phys.-Solid State (Engl. Transl.), 10: 2774-6(May 1969).

Translated from Fiz. Tverd. Tela, 10: 3489-91(Nov. 1968).

A gold-decorating technique was used to study the topography of the distribution of color centers in x-irradiated NaCl single-crystal chips. Gold was deposited on the chips by vacuum sputtering, followed by carbon deposition, and after dissolution in water, the samples were inspected with an electron microscope. Two decoration patterns were observed: an agglomeration in geometrical shapes with parallel lines, and irregularly shaped agglomerates of size 500 to 1000 Å. The results indicate that the color centers are nonuniformly distributed and that neighboring centers interact. It is concluded that the centers which initiate the development of the agglomerates are responsible for coloration as well as luminescence. (D.L.C.)

**30621** TEMPERATURE DEPENDENCE OF THE ELECTRON BOMBARDMENT EFFECTS ON THE ELECTRONIC AND PHYSICAL PROPERTIES OF SEMICONDUCTING THIN FILMS. Ivankiv, L. I.; Palyukh, B. M.; Solyanik, Z. V. (Lvov State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 10: 2694-5(May 1969).

Translated from Fiz. Tverd. Tela, 10: 3412-13(Nov. 1968).

The desorption of $CO_2$ from thin Te layers by low-energy electrons (100 and 500 eV) was studied at 77 to 363°K by means of pressure and resistance changes. The desorption is found to increase exponentially with temperature. A possible hole–electron pair mechanism for the bombardment effects is given. (D.L.C.)

**30622** EFFECT OF TEMPERATURE AND ION BOMBARDMENT ON THE ANGULAR DEPENDENCES OF THE SECONDARY-ELECTRON EMISSION FROM A GERMANIUM SINGLE CRYSTAL. Abroyan, I. A.; Titov, A. I. (Leningrad Polytechnic Inst.). Sov. Phys.-Solid State (Engl. Transl.), 10: 2716-17(May 1969).

Translated from Fiz. Tverd. Tela, 10: 3432-4(Nov. 1968).

A study was made of the effects of departures from ideal crystal structure on the shape of the $\sigma(\phi)$ curves, where $\sigma$ = secondary emission coefficient and $\varphi$ = incident angle of the primary electron beam (2 or 4 keV). For the effects of temperature, $\eta/\eta_{\langle 112\rangle}$ ($\eta$ = fraction of reflected primary electrons at $\varphi$, and $\eta_{\langle 112\rangle}$ = fraction for $\varphi = 6°$, the $\langle 112\rangle$ direction) was plotted versus $\varphi$ at 300, 700, and 1000°K. A temperature increase smooths out the curves but does not alter the positions of the extrema. Surface damage effects were also investigated, using $K^+$ ions at 6 keV in the $\langle 110\rangle$ direction ($\varphi = 36°$). A plot of $\sigma/\sigma_{\varphi=0°}$ vs $\varphi$ shows that the ion damage results in a smoothing of the curves, with the fine structure disappearing at a dose of $2 \times 10^{14}$ ions/cm$^2$. Heating at 650°K restores the initial shape of the curve. (D.L.C.)

**30623** THE FORMATION OF F CENTERS DURING THE DECAY OF X-RAY EXCITED STATES IN IONIC CRYSTALS. Elango, M. A. (Inst. for Physics and Astronomy, Tartu). Sov. Phys.-Solid State (Engl. Transl.), 10: 2718-19(May 1969).

Translated from Fiz. Tverd. Tela, 10: 3434-6(Nov. 1968).

Two mechanisms are discussed for the formation of F centers before the total transformation of x-ray-excited electron states into stable states of the exciton or electron–hole pair type: (1) Varley multiple ionization of anions and (2) radiationless filling of inner holes and ejectron of the excited ion into an interstitial position. Conditions for confirming these mechanisms in alkali metal halides are given. (D.L.C.)

**30624** THEORY OF THE SHADOW EFFECT. Ryabov, V. A. Sov. Phys.-Solid State (Engl. Transl.), 10: 2720-1(May 1969).

Translated from Fiz. Tverd. Tela, 10: 3436-8(Nov. 1968).

The shadow effect appears in the anisotropy of the angular distribution of fast charged particles emitted from a lattice point in single crystals. Calculations were made of the angular distribution of particles for various crystal axes of the bcc lattice. The effects of crystal thickness on the angular distribution were also calculated. Finally, the temperature and energy dependences of the shadow width $\gamma_{0.85}$ were determined. (D.L.C.)

**30625** DISPERSION OF THE ENERGY OF ELECTRONS TRANSMITTED BY THIN FOILS OF MATERIALS AND ITS INFLUENCE ON ELECTRON MICROSCOPY. Verdier, Pierre (CNRS, Toulouse). J. Microscop., 7: 775-92(Nov. 1968). (In French).

When electrons traverse matter their loss of energy varies according to a nongaussian distribution. Applicability of the theory of Makhov which describes the loss of energy of electrons in solids is considered. A function giving the energy distribution of electrons transmitted through thin foils was derived from this semiempiric theory. By use of a 1.5-MeV electron microscope, measurements were made of the values (half-widths and most probable energy) characterizing the energy dispersion for very thin specimens. The microscope was thus used as a velocity analyzer, the resolving power of which was ~1/10,000. These experiments are cited as proof of the great advantage of very high voltage electron microscopy. Quantitative agreement between measurements and theory was obtained for electrons with energies between 300 and 1200 keV. (BBB)

**30626** ELECTRON PARAMAGNETIC RESONANCE IN IRRADIATED ZIRCONS CONTAINING VARIOUS ELEMENTS. Samoilovich, M. I.; Novozhilov, A. I.; Barsanov, G. P. (All-Union Inst. of Mineral Synthesis, Aleksandrov, USSR). Geochem. Int. (Engl. Transl.), 5: 420-2(1968).

Translated from Geokhimiya, No. 4, 494-5(1968).

Irradiated zircon crystals exhibit numerous paramagnetic cen-

ters. Some of these are attributed to Nb and Hf impurities; others remain unidentified. (auth)

**30627** TEMPERATURE DEPENDENCE AND MECHANISMS OF RADIATIVE CREATION OF ELECTRONIC COLOR CENTERS IN KCl AND KCl:Ag CRYSTALS. Muradov, S. M.; Elango, M. A. (Inst. of Physics and Astronomy, Tartu). Sov. Phys.-Solid State (Engl. Transl.), 10: 2548-50(May 1969).

Translated from Fiz. Tverd. Tela, 10: 3218-21(Nov. 1968).

The temperature dependences of the mechanisms for creation of F-, B-, and E-color centers in KCl and KCl–Ag crystals have been studied experimentally above 100°K. It is shown that the experimentally measured growth curves of a number of different color centers can be resolved into 2 or 3 elementary stages with efficiencies having various dependences on the radiation temperature. In the 100–150°K range, the F centers are created as a result of the radiation-free annihilation of excitons which appear as a result of the recombination of electrons with self-localized holes. The introduction of $Ag^+$ ions significantly decreases the efficiency of this process. At higher temperatures, the efficiency of F-, B-, and E-center creation is determined mainly by the existing hole capture centers. The various mechanisms for the creation of F-, B-, and M-color centers in KCl and KCl–Ag crystals are discussed. (auth)

**30628** FRENKEL PAIR FORMATION AND MUTUAL ANNIHILATION IN COBALT. Maury, F.; Lucasson, A.; Lucasson, P. (Laboratoire de Chimie Physique, Orsay, France). Phys. Lett., 29A: 174-5(May 5, 1969).

The energy dependence of atomic displacements in electron-irradiated cobalt at low temperature shows an effective threshold energy $T_d = 24 \pm 2$ eV. Experimental data on the energy dependence of the stage-I recovery substages are discussed. (auth)

**30629** SOME FEATURES OF ZERO-PHONON LINES IN NEUTRON-IRRADIATED MgO. Consadori, F.; Stella, A. (Univ., Pavia, Italy). Nuovo Cim., Lett., 1: 761-5(May 21, 1969).

The absorption and emission spectra of color centers in solids at low temperatures may present some narrow spikes, respectively, on the low- and high-frequency side of the well-known broad and structured bands. These spikes have been explained as being due to purely electronic or zero-phonon transitions. Some features of similar spikes in neutron-irradiated MgO are reported. (M.H.R.)

**30630** ELECTRON ENERGY DISSIPATION. Kobetich, E. J.; Katz, R. (Univ. of Nebraska, Lincoln). Nucl. Instrum. Methods, 71: 226-30(1969).

A new algorithm for the computation of the energy dissipated by normally incident, monoenergetic electron beams, provides good agreement with experimental data and with the computations of Spencer. (auth)

**30631** MEASUREMENT OF THE INTERNAL MAGNETIC FIELD AT OSMIUM AFTER COULOMB RECOIL IMPLANTATION IN IRON. Haberrecker, K.; Fiebiger, N.; Ischenko, G. (Univ., Erlangen-Nuernberg, Ger.). Z. Phys., 223: 54-60(1969). (In German).

The $\gamma$-angular correlation of osmium is measured after Coulomb excitation with 30 MeV $^{16}O$ ions. The recoiling nuclei are implanted into a magnetized iron substrate. The fit of the perturbed angular correlation gives the value $B = -800 \pm 200$ kG for the internal field at the sites of osmium atoms dissolved in an iron host. (auth)

## *Physical Properties*

*Refer also to abstract 30456.*

**30632** (COO-1198-622) HIGH-RESOLUTION FIELD ION MICROSCOPY. Tong, Hua-Ching (Illinois Univ., Urbana). Oct. 1968. Contract AT(11-1)-1198. 136p. Dep. CFSTI.

Thesis.

Defects induced on both the surfaces and the interiors of tungsten wires were studied. Atomic rearrangements on the surfaces caused by strong electric fields were observed. The fine structures of atomic groupings (metastable molecules) at special sites were resolved for the first time. The groupings are classified as triplets, quadruplets, quintuplets, and higher orders. Tungsten specimens were bombarded inside the field ion microscope with energetic helium atoms (with kinetic energies ranging from 100 eV to 5 keV). Some specimens were rotated to place their axes parallel with the ion beam during the bombardment. Others were bombarded in the usual way from the side. Defects generated by the helium–ion bombardment were identified as vacancies, interstitials, and vacancy clusters. Low-temperature interstitial migration was observed between 10 and 50°K. Grain boundaries acting as sinks for interstitials were also observed. Finally, the sputtering threshold energy for a field ion tip was measured. Point defects and stacking faults on {110} with partial dislocation of $\frac{1}{9}a\langle 110\rangle$ were found in tungsten. (auth)

**30633** (GEMP-680) DSPACE: A PROGRAM TO CALCULATE INTERPLANAR SPACINGS FROM LATTICE PARAMETERS. Sjodahl, L. J.; Bartram, S. F.; Rau, R. C. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). Mar. 11, 1969. Contract AT(40-1)-2847. 10p. Dep. CFSTI.

DSPACE is a time-sharing computer program written in the old Basic (ABASIC) language for calculating d-spacings for all planes with nonzero structure factors from the lattice parameters. The procedures for minimizing the number of calculations are described. A listing of the program and the tapes for several common crystal systems are included. (D.L.C.)

**30634** (N-69-13309) POINT DEFECT CALCULATIONS IN TUNGSTEN. Danilowicz, Ronald L. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec. 1968. 14p. (NASA-TN-D-4918). CFSTI.

Calculations were made with a computer code developed for making point defect calculations in body-centered-cubic metals. A semi-empirical cubic potential based on experimental data was also developed for tungsten for these calculations. The vacancy migration energy for tungsten was calculated. The calculated value of 1.73 eV, together with experimental data, suggests that vacancies migrate in stage-3 recovery in tungsten. The formation energies for six possible equilibrium interstitial configurations were also calculated. The ⟨110⟩ split interstitial was the most stable configuration for tungsten with a formation energy of 9.73 eV. (auth) (STAR)

**30635** RADICAL-RECOMBINATION LUMINESCENCE OF BORON NITRIDE. Lubyanskii, G. A.; Styrov, V. V.; Sokolov, V. A. (Tomsk Polytechnical Inst., USSR). Sov. Phys.-Solid State (Engl. Transl.), 10: 2653-6(May 1969).

Translated from Fiz. Tverd. Tela, 10: 3359-63(Nov. 1968).

The spectra, quantum yield, and temperature dependence of the radical-recombination luminescence of boron nitride and the recombination coefficient of hydrogen atoms on the surface of BN were measured. The corresponding photoluminescence characteristics were also measured for comparison. A comparison of this and other data shows that radical-recombination luminescence involves a basic surface luminescence, while in photoexcitation the bulk component predominates (probably nitrogen vacancies). (auth)

**30636** DEPENDENCE OF THE SPECIFIC HEAT OF BERYLLIUM AT LOW TEMPERATURES ON THE IMPURITIES IN THE SAMPLE. Gmelin, E. (Centre National de Recherche sur les Tres Basses Temperatures, Grenoble, France). Z. Naturforsch., 24a: 291-2(Feb. 1969). (In German).

Comparing the low temperature heat capacities of beryllium, measured by various authors it is concluded that the Debye temperature at 0°K and the electronic specific heat of Be are strongly dependent on small impurities ($\leq$10,000 ppm) in the sample. This idea is confirmed by the results of specific heat measurements of three Be-samples, having various purities. (auth)

**30637** FERMI SURFACE OF BERYLLIUM AND ITS PRESSURE DEPENDENCE. Tripp, J. H. (Case Western Reserve Univ., Cleveland); Everett, P. M.; Gordon, W. L.; Stark, R. W. Phys. Rev., 180: 669-78(Apr. 15, 1969).

The Fermi surface of beryllium was thoroughly investigated by means of the de Haas–van Alphen (dHvA) effect, and the frequencies, though substantially in agreement with earlier measurements, were obtained to greater accuracy. This made it possible to construct a nonlocal pseudopotential model for the Fermi surface, in which the Fourier coefficients of the crystal potential are treated as parameters to be evaluated by fitting to the experimental data. In this way, all the principal cross sections of the surface were fitted to within 1%, using only five adjustable parameters. Comparison of calculated cyclotron masses for these cross sections with the masses determined from the temperature dependence of the dHvA amplitudes indicates that the mass is enhanced about 20% by many-body interactions neglected in the model. Finally, the pressure dependence of the Fermi surface has been calculated and compared with some available experimental measurements. (auth)

**30638** MEASUREMENTS OF THE THERMAL HALL EFFECT OF INDIUM. Amundsen, T. (Univ. of Oslo). Phys. Lett., 29A: 209-10(May 5, 1969).

The Righi–Leduc coefficient of polycrystalline indium plates has been measured at liquid helium temperatures. The high field value is found to be in close agreement with theoretical predictions, and the field and temperature dependence is discussed and compared with corresponding results for the electrical Hall coefficient. (auth)

**30639** CHROMIUM-LIKE ANTIFERROMAGNETIC BEHAVIOR OF $CrB_2$. Barnes, R. G.; Creel, R. B. (Ames Lab., Iowa). Phys. Lett., 29A: 203-4(May 5, 1969).

The compound $CrB_2$ is found to order antiferromagnetically on the basis of the extinction of the $^{11}B$ NMR signal, yielding a Néel temperature $T_N = 88.0 \pm 2.0°K$. In contrast, NMR measurements of the magnetic shift anisotropy indicate that $MnB_2$ orders ferromagnetically with $\theta_p = 140 \pm 2.0°K$. (auth)

**30640** USE OF SUPERCONDUCTING CAVITIES TO RESOLVE CARRIER TRAPPING EFFECTS IN CdS. Hartwig, William H.; Hinds, James J. (Univ. of Texas, Austin). J. Appl. Phys., 40: 2020-7(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

The excellent frequency stability and cryogenic environment of a superconducting resonant cavity provides a sensitive method for observing trap-filling in CdS and similar materials. When used with thermally stimulated conductivity and dc photoconductivity, it is possible to solve for trap energy, capture cross section, density of trap states, and free-carrier lifetime. The technique is that used by Arndt, Hartwig, and Stone to observe optically induced changes in the complex dielectric constant by inertia forces on free carriers in Si and other indirect-gap semiconductors. Using TSC, pure CdS crystals showed very weak trapping effects and CdS:Al displayed electron traps at 0.52, 0.35, and a group at 0.265, 0.20, and 0.15 eV. A quenching, or hole trapping, level was seen at 1.6 eV below the conduction band. Deep electron trap densities were about $10^{15}$ $cm^{-3}$ and the shallow set was about $10^{17}$ $cm^{-3}$ each. Hole trap density was slightly in excess of $10^{18}$ $cm^{-3}$. In CdS:Al, the photodielectric frequency shift of an 840 MHz cavity was proportional to the integral of photon flux, indicating the effect was caused by polarization of electrons in traps. Photodielectric data yielded an effective trap energy for the three shallow levels at 0.176 eV and a total density of $3 \times 10^{17}$ $cm^{-3}$. Density of trapped electrons is calculated from frequency change. Capture cross section for the shallow levels was about $10^{-14}$ $cm^2$. Additional data from dc photoconductivity provide free-carrier lifetime and location of the electron Fermi level as a function of filled trap density. CdS:Al displays a "tap" effect which can erase the accumulated frequency change without warming. (auth)

**30641** A NEW ALLOTROPIC FORM OF CERIUM DUE TO ITS TRANSITION UNDER PRESSURE TO THE TETRAVALENT STATE. Franceschi, Enrico; Olcese, Giorgio L. (Univ., Genoa). Phys. Rev. Lett., 22: 1299-1300(June 16, 1969).

An x-ray structural analysis on cerium under pressure was made in order to investigate its valence behavior in the metallic state. A new form, $\alpha'-Ce$, always fcc but strongly collapsed, was found to exist at pressures higher than 50 kbar. It was deduced that Ce is tetravalent in the $\alpha'$ form. The atomic radius of Ce(IV) was calculated, and the probable values of the valency in $\gamma-Ce$ and $\alpha-Ce$ are also estimated. (auth)

**30642** MAGNETIC STRUCTURE AND SPIN-DENSITY DISTRIBUTION IN $UFe_2$. Yessik, M. (Cavendish Lab., Cambridge, Eng.). J. Appl. Phys., 40: 1133-5(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

A study has been made by the diffraction of polarized neutrons of a single crystal of the ferromagnetic compound $UFe_2$ at 84°K ($T/T_C = 0.49$). The flipping ratios of all reflections out to a $\sin\theta/\lambda$ value of 0.41 $A^{-1}$ have been measured. These measurements show that, at this temperature, the Fe atom has a magnetic moment of 0.38 $\mu_B$ and that there is a small but significant moment of the U atom, parallel to the Fe moment, of about 0.03 $\mu_B$. The spin density distribution at the U atom position is very nearly spherically symmetric, but the spin density at the Fe site is seen to have large deviations from spherical symmetry, being elongated in the direction of the cube edges and contracted along the nearest-neighbor connecting line. Good agreement between observed and calculated structure factors is obtained by using a shallow form factor of the $5f^3$ type for the U moment, and by using an Fe form factor calculated on the basis of 65% of the magnetic electrons having $E_g$ symmetry and 35% $T_{2g}$ symmetry. (auth)

**30643** EFFECT OF THE ANISOTROPIC EXCHANGE AND THE CRYSTALLINE FIELD ON THE MAGNETIC SUSCEPTIBILITY OF $Eu_2O_3$. Huang, N. L.; Van Vleck, J. H. (Harvard Univ., Cambridge, Mass.). J. Appl. Phys., 40: 1144-6(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

The combined action of the crystalline field and exchange is invoked in an attempt to explain theoretically why the susceptibility $\chi$ of cubic $Eu_2O_3$ is found by experimenters to be 30% higher than that for the free $Eu^{3+}$ ion at temperatures below 50°K. The crystalline field is known approximately from optical studies, whereas the coefficient in the exchange coupling is treated as an empirical parameter. This parameter cannot be deduced from a comparison with $Gd_2O_3$ as it has been shown elsewhere that there are contributions from anisotropic exchange which do not enter in the coupling of S-state ions such as $Gd^{3+}$, but which do not necessarily vanish for $Eu^{3+}-Eu^{3+}$ interaction. The crystalline field is found to account for only 42% of the observed enhancement of $\chi$, whereas the isotropic exchange of the type present in $Gd_2O_3$ in fact reduces $\chi$ by a small amount, thus demonstrating the importance of the anisotropic exchange. The latter needs to be opposite in sign and five times larger than the conventional isotropic exchange in order to explain the observed $\chi$ at T = 0°K. Then the temperature dependence of $\chi$ calculated with the molecular field approximation agrees with experiment very well. (auth)

**30644** MAGNETIC STRUCTURE PROPERTIES OF Gd-Y AND Gd-Sc ALLOYS. Child, H. R.; Cable, J. W. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 40: 1003-5(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

The magnetic structure properties of several specimens in the gadolinium–scandium and gadolinium–yttrium alloy systems have been determined by neutron diffraction using the low-absorbing isotope $^{160}Gd$. Neutron patterns were taken from annealed powder samples at temperatures from 4 to 300°K. In both systems, the alloys show ferromagnetism at high gadolinium concentrations and antiferromagnetism at low concentrations. The concentration at which this change from ferro- to antiferromagnetism occurs is about 80 at. % for Gd–Y and about 70 at. % for Gd–Sc. The observed antiferromagnetic structures are spiral type with turn angles between the moments in adjacent layers which approach 50° per layer at low Gd concentrations. The ordering temperatures decrease with decreasing Gd concentration more rapidly in the Sc than in the Y alloys. Thus these alloys behave similarly to the other rare earth Y and Sc alloys studied previously. Dilution of Gd by Y and Sc affects the anisotropy of gadolinium differently. An 80 at. % Gd in Sc alloy has a temperature variation of the angle the ferromagnetic moment makes with the c axis similar to pure Gd in which this angle is 0° at $T_c$, increases to 65° as the temperature is lowered, and then returns to about 32° at very low temperatures. An 80 at. % Gd in Y alloy, on the other hand, has its ferromagnetic moment about 70° from the c axis at all temperatures below $T_c$. In both systems, the antiferromagnetic spiral structure has the moments in the base plane perpendicular to the c axis. (auth)

**30645** PARTIAL QUENCHING OF RARE EARTH MOMENT IN CUBIC LAVES INTERMETALLIC COMPOUNDS. McDermott, M. J.; Marklund, K. K. (Oxford Univ.). J. Appl. Phys., 40: 1007-8(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

Measurements of the low-temperature (0.1 to 1.0°K) heat capacities of several cubic Laves intermetallic compounds containing praseodymium indicate the presence of a substantial nuclear hyperfine contribution to the specific heat. It is possible to relate the magnitude of this contribution to the magnetic moment carried by the $Pr^{3+}$ ion in each of the materials studied. The moments deduced in this way are $PrNi_2$, 0.582 ± 0.006; $PrCo_2$, 2.18 ± 0.05; $PrAl_2$, 2.65 ± 0.03 $\mu_B$. These are each significantly less than the free $Pr^{3+}$ ionic moment of 3.20 $\mu_B$. The results are discussed in terms of a theory of Bleaney and it is concluded that the crystalline electric field is the same in $PrCo_2$ and $PrNi_2$, the large moment in the former being due to a larger exchange interaction. In the case of $PrAl_2$, the data indicate an accidental degeneracy in the crystalline field ground state. (auth)

**30646** MAGNETIC STRUCTURE AND EXCHANGE INTERACTIONS IN CUBIC GADOLINIUM COMPOUNDS. McGuire, T. R. (IBM Research Div., Yorktown Heights, N. Y.); Gambino, R. J.; Pickart, S. J.; Alperin, H. A. J. Appl. Phys., 40: 1009-10 (Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

The two groups of metallic compounds $Gd^{3+}X^{3-}$(X = N, P, As, Sb, Bi) and $Gd^{2+}Z^{2-}$(Z = S, Se, Te) have the rocksalt structure and except for ferromagnetic GdN they are antiferromagnetic. Powder neutron diffraction measurements on GdS, GdSe, GdSb, and GdBi show them to have order of the second kind. The exchange interactions are discussed on the basis of the magnetic structure and susceptibility measurements. (auth)

**30647** THEORY OF THE SUSCEPTIBILITY OF $CeB_6$. Nickerson, J. Charles; White, Robert M. (Stanford Univ., Calif.). J. Appl. Phys., 40: 1011-12(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

Cerium hexaboride is an antiferromagnetic metal with a Néel temperature of 3°K. The high-temperature inverse susceptibility of this material is observed to decrease with decreasing temperature more rapidly than would be expected from a Curie–Weiss law. Since the temperature at which this deviation appears is much higher than the eventual ordering temperature, short-range ordering effects should be negligible. Also, it can be shown that crystal-field effects alone cannot produce such a decrease in $\chi^{-1}$. A possible mechanism is offered which explains this behavior. Basically, it is assumed that the Ce–Ce exchange arises through an indirect exchange involving the conduction electrons. The conduction electrons are visualized as moving in the spaces between the boron complexes so that the magnitude of the s-f exchange will be different for the different crystal-field states of cerium. In a cubic field, the $^2F_{5/2}$ state of $Ce^{3+}$ splits into a $\Gamma_7$ and a $\Gamma_8$. Low-temperature measurements of the saturation moment indicate that the $\Gamma_7$ state lies lowest. Therefore, as the temperature decreases, the $\Gamma_8$ state, which protrudes into the space between the borons and, hence, contributes strongly to the s-f exchange, is frozen out, leaving only the weakly coupled $\Gamma_7$ state. (auth)

**30648** NEUTRON-DIFFRACTION INVESTIGATION OF THE SPIRAL MAGNETIC STRUCTURE IN $Cr_2BeO_4$. Cox, D. E. (Brookhaven National Lab., Upton, N. Y.); Frazer, B. C.; Newnham, R. E.; Santoro, R. P. J. Appl. Phys., 40: 1124-5(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

$Cr_2BeO_4$ is orthorhombic with the olivine ($Mg_2SiO_4$) type of crystal structure. Previous magnetic susceptibility, neutron diffraction, and AFMR measurements have revealed that the compound undergoes an antiferromagnetic transition at about 28°K, probably to a noncollinear spin arrangement. More accurate neutron-powder data have been obtained at 4.5°K with 1.1- and 2.5-Å neutrons which reveal that the magnetic structure is a cycloidal spiral having a propagation vector directed along the c axis (Pbnm orientation). The spiral periodicity is about 65 Å, which is roughly 12 times the unit cell length in this direction. The observed intensities are accounted for reasonably well by a simple model in which there is modulation of a basic antiferromagnetic arrangement consisting of a G mode on the Cr(I) inversion sites coupled with a G mode on the Cr(II) mirror sites. The moments lie in the ac plane, and there is an additional phase factor of 90° between the moments of the Cr ions on the two kinds of sites. (auth)

**30649** KONDO PHENOMENON IN DILUTE LANTHANUM–CERIUM SOLID SOLUTIONS. Arajs, Sigurds; Anderson, Elmer E. (Clarkson Coll. of Tech., Potsdam, N. Y.). J. Appl. Phys., 40: 1470-2(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

The manifestations of the Kondo effect in lanthanum-rich fcc lanthanum–cerium solid solutions, containing 0.9, 2.0, 2.5, 3.9, 6.0, 6.5, and 8.5 at. % Ce, have been studied by electrical transport property measurements. The electrical resistivity data as a function of temperature between 4 and 30°K clearly reveal a resistivity minimum in all above-mentioned alloys. The temperature at which the minimum occurs is almost independent of cerium concentration: it gradually changes from 5.8–7.4°K, associated with 0.9 at. % Ce- and 8.5 at. % Ce-alloy, respectively. The depth of the resistivity minimum, measured with respect to 4.2°K, increases from 0.01 μΩ-cm (0.9 at. % Ce) to 0.13 μΩ-cm (8.5 at. % Ce) with increasing cerium content. The additional electrical resistivity due to dissolved cerium in lanthanum is proportional to ln T, where T is the absolute temperature, for temperatures below 12°K. The total electrical magnetoresistivity studies at 4.2°K, made with longitudinal magnetic fields up to 60 kOe, show the following behavior: The resistivity increase with increasing fields is positive for pure normal lanthanum, almost independent of field for 0.9 at. % cerium alloy, and negative for all other lanthanum alloys. The absolute value of the magnetoresistivity increases with increasing cerium concentration. All these observations result from the localized magnetic moments associated with cerium dissolved in lanthanum. (auth)

**30650** SPIN-WAVE DISPERSION RELATION FOR HOLMIUM IN THE SPIRAL MAGNETIC PHASE. Nicklow, R. M.; Mook, H. A.; Smith, H. G.; Reed, R. E.; Wilkinson, M. K. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 40: 1452-3(Mar. 1, 1969).

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The spin-wave dispersion relation for the c direction of holmium metal in its plane-spiral magnetic phase has been studied by coherent inelastic scattering of thermal neutrons. Constant-Q measurements of neutron energy loss processes, with the scattered neutron energy held fixed at 8.5 MeV, were made at 78 and 48°K. Preliminary least-squares analyses of the data indicate that the out-of-plane anisotropy constant is smaller than that for Dy and Tb, and that five interplanar exchange constants are required in order to fit the data satisfactorily. The resulting exchange constants are larger in magnitude than the anisotropy constant and are both positive and negative in sign as expected for the stability of the spiral structure. (auth)

**30651** SPIN-WAVE EXCITATIONS IN THE CONICAL AND SPIRAL MAGNETIC PHASES OF HOLMIUM METAL. Stringfellow, M. W.; Holden, T. M.; Powell, B. M.; Woods, A. D. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Appl. Phys., 40: 1443-5(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

Spin-wave excitations propagating along the c and a axes of holmium metal have been studied by neutron inelastic scattering techniques, with a triple-axis spectrometer in both the constant Q and constant energy-transfer modes of operation. Measurements were made in the conical magnetic phase at a temperature of 4.6°K and in the spiral phase at 25°K. The dispersion curves for the two phases are similar in shape, although the spin-wave energies in the spiral phase are consistently lower than in the conical phase. For example, the energies of spin waves of wave vector (0, 0, $2\pi/c$) are 3.97 ± 0.21 and 3.48 ± 0.21 MeV in the conical and spiral phases, respectively, while those of spin waves of wave vector (0, 0, $\pi/c$) are 2.64 ± 0.21 and 2.07 ± 0.17 MeV, respectively. The results give information about the Fourier-transformed exchange, J(0)–J(q), and the crystal field parameters. (auth)

**30652** MAGNETIZATION AND SPECIFIC HEAT OF Fe–Be ALLOYS. Herr, A.; Kuentzler, R.; Meyer, A. J. P. (Institut de Physique, Strasbourg). J. Appl. Phys., 40: 1375-6(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

Magnetic and electronic specific-heat measurements show that the s electrons of Be are not transferred to the d band in Fe–Be solid solution, but that this transfer occurs in the $FeBe_2$–$FeBe_5$ range at a rate of 0.6 electrons per Be atom while 1.4 electrons of Be remain in s state. This behavior is interpreted in supposing that the free-electron density of iron $n_s = 0.9$ has to be increased near $n_d = 1.4$ by the solute electrons before s → d transfer can occur. This model applies qualitatively to the observed data of Fe–Al and Fe–Si solid solutions. (auth)

**30653** FERMI SURFACES AND GENERALIZED SUSCEPTIBILITIES FOR NEODYMIUM AND PRASEODYMIUM. Fleming, G. S.; Liu, S. H.; Loucks, T. L. (Ames Lab., Iowa). J. Appl. Phys., 40: 1285-6(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

Using the energy bands which were previously calculated for double hexagonal-close-packed neodymium and praseodymium, calculations were made of the generalized susceptibilities, $\chi(q)$, along several directions in the ΓMLA plane of the Brillouin zone. The bands were calculated using the relativistic APW method and the procedures used in calculating the susceptibility were similar to those employed by Evenson and Liu for their work on the heavy rare-earth metals. There are several relatively flat pieces of Fermi surface nearly parallel to the KMLH plane which nest into each other. This nesting produces a peak in the susceptibility curve along ΓM at approximately $0.13b_1$. This wavevector corresponds to the b-axis periodicity of the magnetic ordering for these two elements determined by neutron-diffraction measurements. (auth)

**30654** KONDO TEMPERATURE INDEPENDENT OF HOST COMPOSITION OF Co DISSOLVED IN Mo–Nb ALLOYS. Sarachik, M. P. (City Coll. of New York); Knapp, G. S. J. Appl. Phys., 40: 1105-6(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

Evidence, based on resistivity and susceptibility measurements, is presented that the Kondo temperature $T_K$ of Mo–Nb alloys containing Co is essentially independent of the host Mo–Nb composition. Since the density of states N(0) of these alloys is known to change by about 20%, the above data indicates that $T_K$ does not vary as $\exp[-1/N(0)J]$, or that N(0)J must remain constant. (auth)

**30655** ANALYSIS BY REPRESENTATION THEORY OF HELICAL SPIN STRUCTURES. APPLICATION TO Dy AND MnP. Bertaut, E. F. (Centre National de la Recherche Scientifique, Grenoble, France. Centre d'Etudes Nucleaires, Grenoble, France). J. Appl. Phys., 40: 1592-3(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

Representation analysis of magnetic structures were extended to arbitrary wave vectors k by defining "k components of spins"

which transform like Bloch waves. The theory provides all possible isotropic and anisotropic couplings which are compatible with k. Applied to the helical structure of Dy the theory shows that antisymmetric coupling cannot be ruled out. For MnP, the possible presence of antisymmetric coupling provides an explanation which is different from that recently forwarded by Takeuchi and Motizuki. (auth)

**30656** FAR-INFRARED FERROMAGNETIC RESONANCE IN DYSPROSIUM AND TERBIUM METALS. Marsh, H. S.; Sievers, A. J. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-2391. J. Appl. Phys., 40: 1563-4(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

The surface impedances of polycrystalline Dy and Tb metals have been measured between 3 and 30 $cm^{-1}$ as a function of temperature from liquid-helium temperature to 153°K. In zero magnetic field, the surface impedance in each case can be separated into two components. A broad background which increases with increasing frequency and temperature has been identified with conduction processes. A strong ferromagnetic resonance is superimposed on this background, and its frequency decreases monotonically with increasing temperature. The resonance frequency decreases from 24.2 $cm^{-1}$ at 4.2°K to 9.2 $cm^{-1}$ at 80°K in dysprosium, and from 13.7 $cm^{-1}$ at 4.8°K to 4.7 $cm^{-1}$ at 153°K in Tb. In the temperature ranges studied, both metals are planar ferromagnets with gaps in the spin-wave spectra due to large uniaxial and hexagonal anisotropies. The results in both cases can be explained by the addition of a magnetoelastic contribution to the spin-wave energies first proposed by Turov and Shavrov and calculated by Cooper. (auth)

**30657** SOME OPTICAL PROPERTIES OF CRYSTALLINE $LaB_6$. Kierzek-Pecold, E. (Inst. of Physics, Warsaw); Kolodziejczak, J.; Niemyski, T.; Michalak, A. Acta Phys. Pol., 35: 849-55(May 1969).

The ultraviolet reflectivity and the plasma reflection edge in crystalline samples of $LaB_6$ were investigated. The spectral dependences of the optical constants were calculated in the region 1.1 to 6.0 eV, using Kramers–Kronig method. The dielectric constant and carrier concentration to the effective mass ratio $N/m^*$ were evaluated by application of Drude's theory. (auth)

## *Moessbauer Effects and NMR*

*Refer also to abstract 29158.*

**30658** THEORY OF NUCLEAR MAGNETIC RESONANCE SUSCEPTIBILITY OF MAGNETIC SUBSTANCES. Turov, E. A.; Kurkin, M. I. (Inst. of Physics of Metals, Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.), 10: 2551-7(May 1969).

Translated from Fiz. Tverd. Tela, 10: 3222-32(Nov. 1968).

The high-frequency magnetic susceptibility of an entire system of electrons and lattice and nuclear spins is calculated. The calculation is made under the following assumptions: 1) the amplitude of the electromagnetic field is sufficiently small to allow the use of linear equations for the susceptibility of the system to the external forces; 2) the concentration of magnetic nuclei is small enough so that one can neglect the interactions between nuclear spins (both direct and indirect); 3) the interaction of the nuclear spin with the fluctuations of the local field is considered a perturbation. A method is suggested which permits all the characteristics of nuclear magnetic resonance to be expressed in terms of the correlation functions of the system of electrons and the lattice without specifying the form of the Hamiltonian for the electrons and lattice. This enables the use of the results obtained for the calculation of NMR characteristics in magnetic materials having complicated magnetic structures. (auth)

**30659** MOESSBAUER-EFFECT STUDY OF REACTOR IRRADIATION OF TIN MONOXIDE. Bondarevskii, S. I.; Seregin, P. O. (Leningrad State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 10: 2736-7(May 1969).

Translated from Fiz. Tverd. Tela, 10: 3454-5(Nov. 1968).

$^{118}SnO$ and natural SnO were irradiated in a reactor for 5 weeks and 1 min to 70 hr and then used as a Moessbauer source (with $CaSnO_3$ absorber) and absorber (with $Ca^{118m}SnO_3$ source), respectively. The Moessbauer spectrum of irradiated natural SnO showed a tin IV line whose intensity increased with irradiation time, and a possible mechanism for this effect is given. The $^{118}SnO$ spectrum indicates that the $^{119m}Sn$ atoms tend to be stabilized in the SnO "parent" form and that the relaxation time for the highly charged states $Sn^{n+}$ from the strongly converted 65.3-keV transition is less than $10^{-8}$ sec. (D.L.C.)

**30660** ELECTRON PARAMAGNETIC RESONANCE OF $NpO_2^{2+}$ IN $Cs_2UO_2Cl_4$ AND $CsUO_2(NO_3)_3$. Leung, A. F.; Wong, Eugene Y. (Univ. of California, Los Angeles). Phys. Rev., 180: 380-5(Apr. 10, 1969).

The EPR spectra of $NpO_2^{2+}$ in $Cs_2UO_2Cl_4$ and $CsUO_2(NO_3)_3$ have been observed at liquid-helium temperature. The $Np^{5+}$ in its host crystals has been assumed to have an axial symmetry due to the strong $NpO_2^{2+}$ complex. The resonances have been identified and fitted with the axial spin Hamiltonian $\mathcal{H} = g_{\parallel}\beta H_z S_z + g_{\perp}\beta(H_x S_x + H_y S_y) + AI_z S_z + B(I_x S_x + I_y S_y) + P[I - \frac{1}{3}I(I+1)]$. For $NpO_2^{2+}$ in $Cs_2UO_2Cl_4$, the parameters are $g_{\perp} = 1.32 \pm 0.02$, $|A| = 0.009 \pm 0.005$ $cm^{-1}$, $g_{\parallel} = 1.3 \pm 0.3$, $P = -0.016 \pm 0.005$ $cm^{-1}$, and $B = 0.0880 \pm 0.005$ $cm^{-1}$; for $NpO_2^{2+}$ in $CsUO_2(NO_3)_3$ they are $g_{\parallel} = 3.36 \pm 0.04$, $A = 0.166 \pm 0.003$ $cm^{-1}$, $g_{\perp} = 0.20 \pm 0.20$, $P = -0.030 \pm 0.003$ $cm^{-1}$, and $|B| = 0.20 \pm 0.20$ $cm^{-1}$. The nuclear moment of $^{237}Np$ has been calculated as 2.1 $\mu_B$ and 2.9 $\mu_B$ for $Np^{5+}$ in $Cs_2UO_2Cl_4$ and $CsUO_2(NO_3)_3$, respectively. (auth)

**30661** RESONANCE SPECTROSCOPY OF GAMMA RADIATION. Moessbauer, Rudolf L. (Technische Hochschule, Munich). Proc. Robert A. Welch Found. Conf. Chem. Res., 11: 77-105(1968).

From 11th Robert A. Welch Foundation Conference on Chemical Research, Radiation, and the Structure of Matter, Houston, Tex. See CONF-671219.

Most applications of the method of recoilless nuclear resonance absorption are based on the fact that this method provides gamma lines that exhibit natural line widths rather than line widths caused by the thermal Doppler effect. This corresponds to an improvement in frequency determination or an improvement in resolution by up to 10 orders of magnitude. After a discussion of the basics of the Moessbauer effect, further review is devoted to three types of hyperfine interactions, namely: isomer shifts, nuclear quadrupole interactions, and magnetic hyperfine interactions. Other applications of recoilless gamma-absorption spectra are listed but are not discussed. (28 references) (L.M.T.)

**30662** NUCLEAR MAGNETIC RESONANCE IN HEXAGONAL LANTHANUM METAL: KNIGHT SHIFTS, SPIN RELAXATION RATES, AND QUADRUPOLE COUPLING CONSTANTS. Narath, Albert (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., 179: 359-68(Mar. 10, 1969).

The $^{139}La$ nuclear magnetic resonances in the double-hexagonal close-packed (dhcp) form of metallic lanthanum have been studied by spin-echo techniques in the frequency range 6 to 30 MHz and temperatures between ~1 and 210°K. A seven-line powder pattern due to electric quadrupole interactions is observed with $|e^2qQ^{(139)}h^{-1}| = 7.8 \pm 0.3$ MHz. The quadrupole splittings are identical within the experimental uncertainty for the two crystallographic sites. The Knight shifts are very different, however, $K \approx +0.63\%$ and $+1.02\%$ at 4°K, and $K \approx +0.59\%$ and $+0.92\%$ at 210°K. The anisotropic Knight-shift contribution is estimated to be less than 10% of the measured shifts. The average spin-lattice relaxation time for the two sites is $T_1T = 0.56 \pm 0.05$ sec °K. The relaxation time for the site having the smaller Knight shift exceeds that for the other site by a factor of approximately 1.7. A comparison of the average Knight shifts and spin-lattice relaxation rates in dhcp lanthanum with those in hcp scandium and yttrium leads to the conclusion that the direct s-contact interaction is the dominant magnetic-hyperfine mechanism in the Group-IIIB transition metals. (auth)

**30663** MAGNETIC INTERACTIONS BETWEEN RARE-EARTH IONS IN INSULATORS. II. ELECTRON-PARAMAGNETIC-RESONANCE MEASUREMENTS OF $Gd^{3+}$ PAIR AND $Gd^{3+}$–$Eu^{3+}$ INTERACTION CONSTANTS IN $EuCl_3$. Birgeneau, R. J.; Hutchings, M. T.; Wolf, W. P. (Yale Univ., New Haven). Phys. Rev., 179: 275-88(Mar. 10, 1969).

Paramagnetic resonance has been observed from both single ions and isolated pairs of $Gd^{3+}$ in $EuCl_3$ at 77°K and 25.6 GHz. The pair spectra were analyzed in the same way as those observed previously from $Gd^{3+}$ in $LaCl_3$. The results give accurate values for the interaction parameters between both nearest (nn) and next-nearest neighbors (nnn). The dominant terms are of the form of isotropic exchange ($JS_1 \cdot S_2$), with $J_{nn}$ (pair) $= 0.0488 \pm 0.0010$ $cm^{-1}$ and $J_{nnn}$ (pair) $= -0.0637 \pm 0.0020$ $cm^{-1}$. The anisotropic parts of the interactions could be accounted for completely by the calculated magnetic dipole–dipole coupling. Combining these results with earlier measurements in $LaCl_3$, good estimates can be made of the exchange interactions in pure $GdCl_3$: $J_{nn}$ ($GdCl_3$) $= 0.056 \pm 0.006$ $cm^{-1}$ and $J_{nnn}$ ($GdCl_3$) $= -0.064 \pm 0.003$ $cm^{-1}$. These values are in excellent agreement with those inferred from analyses of susceptibility and specific-heat measurements, and they resolve unambiguously earlier uncertainties in the choice of possible parameters. The magnitudes and even the signs of the interactions remain unexplained. From measured g-value shifts relative to $Gd^{3+}$ in $LaCl_3$, it was also possible to estimate the isotropic part of the $Gd^{3+}$–$Eu^{3+}$ exchange interaction: $J_{nn}$ (Gd–Eu) $= 0.052 \pm 0.030$ $cm^{-1}$ and $J_{nnn}$ (Gd–Eu) $= -0.061 \pm 0.030$ $cm^{-1}$. The similarity

of these results to the corresponding $Gd^{3+}-Gd^{3+}$ interactions suggests that the average electron–electron exchange interaction may be relatively insensitive to the particular configuration of the individual ions, as proposed theoretically by Van Vleck. On the other hand, comparisons between the results for different isostructural lattices shows that some of the interactions can be extremely sensitive to even small changes in the neighbor distances, and great care is therefore required in extrapolating from one lattice to another. (auth)

**30664** ON THE DISTINCTION BETWEEN MASS-CHANGE SHIFT AND SECOND-ORDER DOPPLER SHIFT IN THE MOESSBAUER EFFECT. Dehn, J. T. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Phys. Lett., 29A: 132-3 (Apr. 21, 1969).

Pound and Rebka and Josephson independently suggested mechanisms for second-order shifts in the Moessbauer effect. The difference between the two mechanisms is discussed and corrected formulas are derived. (auth)

**30665** COSINE EFFECT IN MOESSBAUER SPECTROSCOPY INVOLVING A SOURCE OF NON-ZERO RADIUS. Riesenman, R.; Steger, J.; Kostiner, E. (Cornell Univ., Ithaca, N. Y.). Nucl. Instrum. Methods, 72: 109-10(1969).

A probability function giving the effect of experimental geometry on the distribution of Doppler velocities for $\gamma$ photons emitted from the surface of a disc-shaped source is derived in detail. A discussion of some important points concerning the use of the function is included. (auth)

**30666** SCATTERING OF GAMMA RAYS BY OPTICAL PHONONS IN BARIUM TITANATE. O'Connor, D. A.; Spicer, E. R. (Univ. of Birmingham, Eng.). Phys. Lett., 29A: 136-7(Apr. 21, 1969).

The effect of the optical phonons associated with the paraelectric–ferroelectric phase transition on the scattering of Mössbauer gamma rays by a single crystal of barium titanate was observed. (auth)

**30667** MOESSBAUER-EFFECT STUDY OF SINGLE-CRYSTAL HOLMIUM. Reese, R. Allan; Barnes, R. G. (Ames Lab., Iowa). J. Appl. Phys., 40: 1493-4(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

The magnetic structures of holmium metal were studied using the 80.6-keV transition of $^{166}Er$. Erbium was introduced, as a dilute impurity, into the single-crystal holmium sources through neutron irradiation. Using a cubic, paramagnetic absorber of $ErAl_3$, the intensities of the five magnetic hyperfine lines were studied as a function of temperature. In the ferromagnetic region ($T < 20°K$), a five-line spectrum with a weak central line was obtained when the c axis of the crystal was aligned parallel to the gamma-ray beam. This spectrum is consistent with the ferromagnetic spiral structure determined from neutron diffraction data. The line intensities are insensitive to the distortion of the spiral in which the magnetic moments are grouped symmetrically about the easy directions of magnetization. The maximum value of $H_e$ (at 4.2°K) is the same as in erbium metal. At 20°K the central line was no longer observable, indicating that the magnetic moments are confined to the basal plane at this temperature. The temperature dependence of the internal magnetic field is also reported. (auth)

**30668** HYPERFINE INTERACTION AND SUSCEPTIBILITY IN SOME ACTINIDE METALS AND INTERMETALLIC COMPOUNDS. Dunlap, B. D.; Brodsky, M. B.; Kalvius, G. M.; Shenoy, G. K.; Lam, D. J. (Argonne National Lab., Ill.). J. Appl. Phys., 40: 1495-6(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

Magnetic effects in a number of actinide metals and intermetallic compounds are being investigated utilizing the 59.6-keV Moessbauer resonance of $^{237}Np$ in conjunction with bulk susceptibility measurements. The cubic Laves phase compound $NpAl_2$ is found to be ferromagnetic. The paramagnetic moment is 2.30 $\mu_B$, somewhat lower than in other cubic Np magnetic materials. The saturation magnetic hyperfine field is found to be (3155 ± 50) kOe. Taking $H(T)/H(0) = D[1 - T/T_c]^\beta$, $D = 1.48 \pm 0.10$, $T_c = 55.8 \pm 0.1$°K, and $\beta = 0.355 \pm 0.017$ for $0.994 > T/T_c > 0.83$. At lower temperatures, departure from molecular field behavior is seen. In cubic actinide magnetic materials, an electric-quadrupole hyperfine interaction will be observed due to alignment of the unquenched orbital momentum. In $NpAl_2$, $e^2qQ = -(27 \pm 1)$ MHz is found. For NpC, which has the NaCl structure, the hyperfine parameters $H_i = (4789 \pm 50)$ kOe and $e^2qQ = (577 \pm 58)$ MHz at 4.2°K are obtained. Metallic neptunium (orthorhombic) and americium (hexagonal) show no magnetic hyperfine coupling at temperatures as low as 1.7°K. (auth)

**30669** MAGNETIC STRUCTURES AND PROPERTIES OF $UFeO_4$. Bacmann, M.; Bertaut, E. F.; Blaise, A.; Chevalier, R.; Roult, G. (Centre d'Etudes Nucleaires, Grenoble, France. Centre National de la Recherche Scientifique, Grenoble, France). J. Appl. Phys., 40: 1131-2(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

Moessbauer effect studies, neutron diffraction, and magnetic measurements show that at $T_N = 55$°K the Fe moments of the orthorhombic compound $UFeO_4$ ($a = 4.88_8$ Å, $b = 11.93_7$ Å, $c = 5.11_0$ Å; space group $Pbcn\text{-}D_{2h}^{14}$) order antiferromagnetically along 0y. Below $T_c = 42$°K, a noncollinear structure develops with a ferromagnetic component along 0z and an antiferromagnetic component along 0x. At 4.2°K, the moment values, determined by neutron diffraction, are 4 $\mu_B$ for the ferromagnetic and 2 $\mu_B$ for the antiferromagnetic component per iron atom. There is also a measurable antiferromagnetic component of about 0.4 $\mu_B$ on the U atom. $UFeO_4$ is one of the rare examples of an oxide which is a ferromagnetic insulator. (auth)

**30670** MAGNETIC BEHAVIOR OF INTERMETALLIC COMPOUNDS OF BERYLLIUM. Wolcott, N. M.; Falge, R. L. Jr.; Bennett, L. H. (National Bureau of Standards, Washington, D. C.). J. Appl. Phys., 40: 1377-8(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

The corroboration by NMR of the ferromagnetism of $CrBe_{12}$ has prompted an NMR investigation of the magnetic properties of other beryllium intermetallic compounds. Magnetic-moment measurements of these materials show complex magnetic behavior at 4.2°K. All samples show strong paramagnetic moments and many exhibit remanence. To provide more information on this magnetic behavior, the $^9Be$ resonance was observed in the following samples, listed in approximate order of their magnetic strength at 4.2°K: $CrBe_{12}$, $ZrBe_2$, $MnBe_8$, $FeBe_{11}$, $MnBe_{12}$, $NbBe_3$, $ZrBe_{13}$, $TaBe_3$, $CrBe_2$, $Nb_3Be_{17}$, $TiBe_{12}$, $NbBe_{12}$, $VBe_{12}$, $MoBe_{12}$, $TaBe_{12}$, $WBe_2$, $Ta_2Be_{17}$, $WBe_{12}$. Magnetization measurements are also reported for $AgBe_{12}$, $FeBe_{12}$, $CoBe_{12}$, $PtBe_{12}$, $PdBe_{12}$, and $AuBe_{12}$. Both the Knight shifts and the linewidths show correlation with the moment measurements. Most of the samples show small magnetic moments, positive Knight shifts, and small linewidths, $\Delta H$, less than (800 A/m = 10 Oe). $ZrBe_2$ and $MnBe_8$ have larger moments, negative values of K (~–0.03% at 300°K) and larger $\Delta H$ [~(1.2 kA/m = 15 Oe) at 300°K]. $CrBe_{12}$, clearly ferromagnetic, with the largest moment (of the compounds studied) has the most negative value of K (–0.19% at 300°K) and the largest $\Delta H$ [(1.83 kA/m = 23 Oe) at 300°K]. From the temperature dependence of the linewidths, it appears that $NbBe_3$ and $CrBe_2$ may be magnetic, although much weaker than $CrBe_{12}$. Anisotropic Knight shifts and first-order quadrupole effects are noted. (auth)

**30671** FIELD AND TEMPERATURE DEPENDENCE OF $^{153}Eu$ SPIN–LATTICE RELAXATION IN FERROMAGNETIC EuO. Guenther, B. D. (Army Missile Command, Redstone Arsenal, Ala.); Christensen, C. R.; Daniel, A. C.; Teaney, D. T. J. Appl. Phys., 40: 1404-5(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

Nuclear spin–lattice relaxation times, $T_1$, of $^{153}Eu$ have been measured in an irregularly shaped single crystal of EuO over the temperature range of $1.2° \leq T \leq 4.2$°K and magnetic field range of $0 \leq H_0 \leq 14$ kOe for the crystal orientation $H_0 \perp H_{rf} \parallel \langle 110 \rangle$ by use of the spin-echo technique. The relaxation process was found to satisfy $T_1 \propto T^{-n}$, where n increases from approximately 2–3 as $H_0$ increases from zero to 10 kOe. The $T_1$ is essentially field independent up to $H_0 \approx 6$ kOe. The analysis of these data is complicated by the irregular shape of the sample and the high saturation magnetization, $4\pi M_0 = 24$ kOe, for EuO. Within these limitations these results have been compared with the theory developed by Honma for EuS. (auth)

**30672** ANOMALOUS CRITICAL-POINT BEHAVIOR IN EUROPIUM METAL. Cohen, R. L.; Huefner, S.; West, K. W. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 40: 1366-7(Mar. 1, 1969).

From 14th Conference on Magnetism and Magnetic Materials, New York. See CONF-681121.

Moessbauer-effect measurements of the hyperfine (hf) interaction in Eu metal were used to study the behavior of its sublattice magnetization just below the Néel temperature. From about $0.9 \leq T/T_c \leq 0.99$, the hf field is accurately proportional to $(1 - T/T_c)^\beta$ with $\beta = 0.20$, but at 0.99 $T_c$, the hf field falls from 0.4 of saturation to zero. This can be explained by the existence of a first-order transition coincident with the magnetic ordering. (auth)

# Theoretical Physics

*Refer also to abstracts 30463 and 30825.*

**30673** THERMAL CONTENT OF QUANTUM STATES. Gilson, J. G. (Queen Mary Coll., London). Z. Naturforsch., 24a: 198-200(Feb, 1969).

It is shown that the exact structure of Schroedinger quantum mechanics is a consequence of the assumption that there exist two subquantum fluids in local thermal equilibrium. (auth)

**30674** COMBINATORIAL APPROACH TO THE N-REPRESENTABILITY OF p-DENSITY MATRICES. Yoseloff, Mark L.; Kuhn, Harold W. (Princeton Univ., N. J.). J. Math. Phys. (N. Y.), 10: 703-6(Apr, 1969).

The determination of N-representability (for diagonal elements) of p density matrices restricted to certain finite dimensional subspaces of $l_2$ of the configuration space of N identical antisymmetric particles is considered. In particular, an arbitrary set of N + p spin orbitals is selected and one considers the (N + p/p)-dimensional subspace generated by all possible Slater determinants of the spin orbitals being considered. Applying a combinatorial approach to the problem, a necessary and sufficient set of conditions is determined; previous work has dealt only with necessary conditions, except in the 1-matrix case. The paper concludes by presenting a probabilistic interpretation of these conditions which seems of particular interest for the 2-matrix case. The conditions presented here in combination with the Pauli Principle give a probabilistic view of the expected occupation of p-tuples of spin orbitals in terms of the expected occupations of lower-order-tuples of spin orbitals. (auth)

**30675** HARTREE-FOCK AND HARTREE-BOGÓLYUBOV EQUATIONS WITH EXACT SYMMETRIES. Friederich, A. (Univ., Bonn). Z. Phys., 223: 152-61(1969). (In German).

Generalized HF- and HB-equations fitted for building the symmetry properties of the Hamiltonian are constructed. Therefore the method of Green's functions for condensed systems is used. The structure of HF- and HB-equations is conserved, only the density and pairing matrices change. Physical quantities may easily be calculated. (auth)

**30676** MOMENT-CONSERVING DECOUPLING PROCEDURE FOR MANY-BODY PROBLEMS. Tahir-Kehli, Raza A.; Jarrett, H. S. (E. I. du Pont de Nemours and Co., Wilmington, Del.). Phys. Rev., 180: 544-6(Apr. 10, 1969).

A new, well-defined procedure for linearizing double-time, statistical Green's functions is proposed. The resultant spectral function automatically conserves the first several frequency moments. This compares very favorably with the usual mean-field decoupling results, which conserve only the first (and, rarely, up to three) frequency moments. (auth)

**30677** SELF-CONSISTENT HIGHER-ORDER CORRECTIONS TO THE DIELECTRIC SCREENING FUNCTION. Straessler, S. (Brown Boveri Research Center, Baden, Switzerland). Phys. Rev., 180: 517-19(Apr. 10, 1969).

An evaluation is carried out for the dielectric screening function of a free-electron gas. Self-energy and exchange ladder diagrams are included, taking an effective Yukawa interaction as a model. It is shown that using a self-consistent interaction instead of a random-phase-approximation interaction gives an appreciable correction to the dielectric function. (auth)

**30678** GENERALIZATION OF CASE'S TRANSFORMATION OF THE DIRAC EQUATION. Garszczynski, F.; Hanus, W. (Nicholas Copernicus Univ., Torun, Poland). Acta Phys. Pol., 35: 517-22(Apr. 1969).

A transformation of the inhomogeneous Dirac equation is proposed which: (1) gives insight into the kinematical and dynamical aspects of the problem of separating positive and negative energy states of the Dirac particle, (2) stresses the difference between the roles of the magnetic and electric stationary fields in such a procedure. The explicit formula for the transformed Hamiltonian is derived and interpreted. It is given in a finite form as well as in an expansion into a series. A simple geometrical interpretation follows the calculation. (auth)

**30679** THE IMPOSITION OF EMPIRICAL ACCEPTABILITY CONDITIONS ON SEQUENCES OF SINGLE MEASUREMENTS. Benioff, Paul A. (Argonne National Lab., Ill.). Z. Naturforsch., 24a: 86-96(Jan. 1969).

Difficulties resulting from the application of any empirical acceptability conditions on sequences of single measurements are investigated. In particular, the often-used acceptability requirement that each single measurement be made under the "same conditions" is discussed. In quantum mechanics, this means that each single measurement is made of the same physical quantity on a system in an ensemble of identically prepared systems. One of the resultant difficulties is that such an application leads to an infinite regression of sequences of single measurements. That is, it does not account for the fact that an observer must start the process of measurement or knowledge acquisition. Furthermore, it is seen that there are some basic sequences of single measurements for which an observer can not possibly know at the outset that the "same condition" requirements are satisfied. These include those measurements by which the homogeneity of space–time is tested. The possible relevance of these difficulties to physics is shown by first considering two possibilities of avoiding these difficulties. One is that the "same condition" requirements can be given the weaker interpretation that there be no physical principle forbidding an observer from knowing in terms of limit empirical means, that they are satisfied at the outset of any sequence. This gets rid of the infinite-regression problem as it does not mean that an observer must know in fact that these requirements are satisfied. The other possibility is that if physics does not forbid one in principle from measuring an expectation value in an arbitrarily small time interval then both the basic sequence as well as those by which one knows the "same" requirements are satisfied can be relegated to arbitrarily small time intervals. As far as physics is concerned then, the epistemological difficulties, while existing in these small intervals, do not exist for other times or almost all time. It is then shown that quantum mechanics, as distinct from classical mechanics, and the special relativity require that an infinite time interval is necessary to measure, as a limit mean, any expectation value. Thus physics denies both the above possibilities as it forbids an observer from knowing, even in principle, by any finite time that the "same" requirements are satisfied. Also, physics forbids the relegation of the epistemological problems to arbitrarily small time intervals. (auth)

**30680** METOD FAZOVYKH FUNKTSII V KVANTOVOI MEKHANIKE. (The Method of Phase Functions in Quantum Mechanics). Babikov, V. V. Moscow, Izdatel'stvo Nauka Fiziko-Matematicheskoi Literatury, 1968. 224p.

An account is given of a simple and effective method further developed recently for the solution of problems in nonrelativistic quantum mechanics. The fundamental method of phase equations is formulated. Phase functions, which have a physical straight line, the sense of which is observed in experimental values, are studied. The advantages, based on the utilization of wave functions, are discussed for the given method relative to the standard approach. New algorithms are constructed for the accurate calculation of phases, scattering length amplitudes, effective radii, coefficients for penetrating potential barriers, energies of related states, and Green functions. In the framework of the phase function method, approximate methods, perturbation theory, the linearization method, and the quasi-classical approach are studied. Besides the central potential, more complex cases of dispersion potentials are examined; these are noncentral, nonlocal, complex potentials, and those depending on momentum. (tr-auth)

**30681** ON SOME PROPERTIES OF THE SCHRAUBEN FUNCTIONS IN CONNECTION WITH THE MAGNETIC OPERATORS. Jannussis, A. D.; Tsilimigras, P. I. (Demokritos Nuclear Research Center, Athens). Z. Naturforsch., 24a: 340-4 (Mar. 1969).

Two new "magnetic" operators are introduced and it is shown that these are the creation and annihilation operators of the schrauben functions. The schrauben functions are the eigenfunctions of the Hamilton operator describing a free electron under the action of a uniform magnetic field. By transforming these two operators one obtains two other operators which are shown to be of Harpers type, as was expected. (auth)

**30682** SOLUTION OF THE DIRAC EQUATION FOR THE RECTILINEAR PERIODIC MOTION OF AN ELECTRON. Jannussis, A. D. (Demokritos Nuclear Research Center, Athens). Z. Naturforsch., 24a: 344-9(Mar. 1969).

The Dirac equation for a rectilinear one-dimensional periodic potential is treated. It is shown that the energy eigenvalues are periodic functions of the wave number $K_x$ and the continuous spectrum is split into energy bands. The end points of the energy bands are the points where the Bragg reflection takes place. These results are obtained by perturbation theory, as well as by the method of determinants, since the resulting eigenvalue equation has the form of a determinant which is similar to the Hill determinant. (auth)

**30683** ONE-PARTICLE OPERATORS FOR THE DIRAC PARTICLE. Janyszek, H.; Rakowski, A. (Nicholas Copernicus Univ., Torun, Poland). Acta Phys. Pol., 35: 529-33(Apr. 1969).

Various schemes of one-particle operators (expressed in terms of the projection operators into the positive and negative energy states) are defined and their properties investigated. The promi-

nent role of the Foldy–Wouthuysen scheme within this set was confirmed. (auth)

**30684** THE CREATION OF A LOW-ENERGY DISCRETE STATE IN THE DISCRETE-STATE CONTINUUM AND CONTINUUM–CONTINUUM INTERACTION. Riess, I. (Technion-Israel Inst. of Tech., Haifa). Phys. Lett., 29A: 128-9(Apr. 21, 1969).

The interaction of a discrete state with a one-dimensional free-particle continuum or the continuum–continuum interaction results in a new continuum similar to the perturbed one, and in an additional discrete level below the continuum. (auth)

**30685** SURVEY OF APPLICABLE MATHEMATICS. Rektorys, Karel (ed.). Cambridge, Mass., Massachusetts Institute of Technology Press, 1969. 1369p. $16.95.

Translated by Rudolf Vyborny.

A mathematics reference book for engineers and scientists is presented. Its 35 chapters range from algebra through the calculus, modern analysis and differential equations to numerical analysis, probability, and statistics. Chapters on nomography, functional analysis, variational calculus, and Fredholm integral equations are included. An extensive table of solutions of differential equations is also included. (C.E.S.)

**30686** FIELD THEORY WITH HIGHER DERIVATIVES: HAMILTONIAN STRUCTURE. Coelho de Souza, L. M. C.; Rodrigues, P. R. (Univ. of Rio Grande, Porto Alegre, Brazil). J. Phys., A (London), 2: 304-10(May 1969).

Canonical formalism including Hamilton's equations, transformation theory, and Poisson brackets for classical field theory with higher time and/or spatial derivatives is established. (auth) (UK)

**30687** METHODS TO CALCULATE PHASE-SPACE INTEGRALS AND DISTRIBUTIONS. Kolkunov, V. A.; Meiman, N. N.; Nikolaevskii, E. S. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 9: 552-64(Mar. 1969). (In Russian).

Calculation of phase-space integrals that are reduced to simple contour integrals is considered. Deforming the contour and transforming the integrand, one can represent them as integrals of exponentially decreasing functions that permit calculation with a computer and making analytical estimates. One of the most important integrals, phase-space volume, is estimated as a function of the number of the particles by means of the saddle-point method. The techniques of calculations of the phase-space volume is applied to obtain various distributions on the basis of the phase-space volume model. (auth)

# PHYSICS (HIGH ENERGY)

## Particle Interactions and Properties (Experimental)

*Refer also to abstracts 30856, 30921, and 31059.*

**30688** (DNPL/R-3) EXPERIMENTAL UTILISATION OF A NINA BOOSTER. Murphy, P. G.; Clegg, A. B. (eds.) (Daresbury Nuclear Physics Lab. (England)). 1969. 68p. Dep.

For details of the NINA BOOSTER reference is made to report DNPL/R.2. Some possibilities for physics experiments on this 20-GeV booster are outlined, with a view to justifying its construction; these include: photoproduction of $\phi$-mesons in the range 5 to 20 GeV/c; photoproduction of complicated final states; electroproduction of N*(1236) isobar at $q^2 = 5.0$ $(GeV/c)^2$; electroproduction of $\rho^0$-mesons; electroproduction of neutral mesons; yields of meson from a 20 GeV electron synchrotron; $K^0_L$ beams; experiments with muon beams; and photoproduction of lepton pairs. (UK)

**30689** (RHEL/R-180) THE WORK OF THE RUTHERFORD LABORATORY IN 1968. Banford, A. P.; Telling, F. M. (Rutherford High Energy Lab., Chilton (England)). 1969. 138p. Dep. UK 15s. 0d.

Work is described on a wide range of topics, including elastic scattering cross-sections and polarizations, bubble chamber studies, and investigations concerned with weak interactions. Some of this work has involved the use of advanced spark chamber and on-line computer techniques. Two NIMROD extracted proton beams have been in use, with ability to switch from one to the other during the pulse. The report is divided into the following sections: High energy physics division; NIMROD division; proton linear accelerator division; applied physics division; engineering division; and administration division. A list of publications by the staff is also included. (UK)

### *Electromagnetic*

*Refer also to abstracts 30375, 30928, 30930, and 30931.*

**30690** (AD-683704) ELECTRON-INDUCED CASCADE SHOWERS IN WATER AND ALUMINUM. Whitney, Randy R.; Zeman, H. D.; Crannell, Carol Jo; Crannell, Hall (Stanford Univ., Calif. High-Energy Physics Lab.). Nov. 1968. Contract Nonr-225(67). 27p. (HEPL-588). CFSTI.

In the present experiment, the three-dimensional distribution of energy deposition was measured for 1-GeV electron-induced showers in water and aluminum. For the water target, two different detectors were employed: CsI(Tl) and anthracene. The measured longitudinal distribution of energy in water was found to be essentially independent of the detector employed in the measurement, while the radial distribution of energy deposition shows a strong detector dependence. Data were measured for the aluminum target with a CaF2(Eu) detector. All of these data support the description that the primary energy-deposition mechanism at the initiation of the shower is ionization of the target material and that the principal energy-transport mechanism after shower maximum is the propagation of minimum attenuation gamma-rays. The radial distributions of energy deposition show that the apparent dependence on the atomic number of the target observed in an earlier experiment was in part a detector-dependent result. The radial distributions, nevertheless, show significant differences from the prediction based on the Monte Carlo calculations of Nagel. (auth) (USGRDR)

**30691** (AD-683705) EXPERIMENTAL DETERMINATION OF THE TRANSITION EFFECT IN ELECTROMAGNETIC CASCADE SHOWERS. Whitney, Randy R.; Crannell, Carol Jo; Crannell, Hall; Gillespie, C. Richard; Pinkau, Klaus (Stanford Univ., Calif. High-Energy Physics Lab.). Nov. 1968. Contract Nonr 225(67). 26p. (HEPL-587). CFSTI.

The transition effect, occurring when an electromagnetic cascade crosses the boundary between different materials, was measured. This transition effect is a rapid change in the numbers and spectra of electrons and photons which constitute the cascade and in the resultant energy deposition. The magnitude of this effect depends on the age of the shower at the discontinuity in the critical energies. (auth) (USGRDR)

**30692** (CEA-R-3601) CONSERVATION OF CHARGE CONJUGATION IN ETA MESON DECAY. Muller, Armand (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1969. 94p. (In French). Dep.

Thesis. Submitted to Univ., Strasbourg.

The charge asymmetry in the $\eta$ meson decay is investigated. With 10709 events $\eta \rightarrow \pi^+\pi^-\pi^0$ the asymmetry is $(0.3 \pm 1.1)$ per cent. The 1620 decays $\eta \rightarrow \pi^+\pi^-\gamma$ give $(1.5 \pm 2.5)$ per cent. There is no evidence for charge conjugation violation in electromagnetic or semi-strong interactions. (auth)

**30693** (CERN-Trans-68-18) THE ANGULAR AND ENERGY DEPENDANCE OF THE EFFECTIVE CROSS SECTION FOR THE PHOTO PRODUCTION OF MESONS $\pi^+$ ON THE PROTONS IN THE RANGE OF ENERGY NEAR THE THRESHOLD. Adamovich, M. I.; Larionova, V. G.; Latypova, R. A.; Kharlamov, C. P.; Yagudina, F. R. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated into French by N. Mouravieff and F. Quanquin from Russian report. 39p. (In French). Dep.

The form of the energy dependence of the differential cross section for photoproduction of mesons $(\pi^+)$ was determined for seven angles $\theta$ in the center of mass system for an energy interval of photons between threshold and 200 MeV. The threshold value of the electric dipole amplitude squared $E^2_{0+} = (16.0 \pm 0.30)(10)^{-30}$ $cm^2$ was obtained. A general analogous statistical treatment was carried out for present and previous data. The analysis of the angular distributions shows a considerable effect of the direct interaction between the photon and the meson current on the form of the angular distributions for energies up to 230 MeV. By an extrapolation of the angular distribution for a unique pion pole $\cos\theta = 1/\beta$, one obtains a value for the pion–nucleon coupling constant $f^2 = (0.07 \pm 0.01)$. (tr-auth)

**30694** (DESY-69/14) COHERENT BREMSSTRAHLUNG OF ELECTRONS IN CRYSTALS. Timm, U. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Mar. 1969. 80p. Dep.

The interferential phenomena of high energy bremsstrahlung in crystals are considered. It is explained how the kinematical restrictions of the process and the interferential selection of nuclear recoils act together to obtain an energy-proportional intensity spectrum and high linear polarization. Formulas for intensity and polarization as functions of quantum energy are presented and discussed, particularly with respect to experimental limitations. The work is based on experimental and theoretical investigations carried out at Deutsches Elektronen-Synchrotron DESY, Hamburg, at electron energies of 6 GeV. (auth)

**30695** PHOTOPRODUCTION OF MUON PAIRS AT 7 TO 9 GeV. Hayes, S.; Imlay, R.; Joseph, P. M.; Keizer, A. S.; Knowles, J.; Stein, P. C. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 22: 1134-7(May 26, 1969).

The photoproduction of wide-angle muon pairs from carbon was measured in order to test the validity of quantum electrodynamics at small distances. The data extend to a muon-pair invariant mass of about 1150 MeV and is consistent with quantum electrodynamics. (auth)

**30696** PHOTOPRODUCTION OF $K^+\Lambda$ AND $K^+\Sigma^0$ FROM HYDROGEN FROM 5 TO 16 GeV. Boyarski, A. M.; Bulos, F.; Busza, W.; Diebold, R.; Ecklund, S. D.; Fischer, G. E.; Murata, Y.; Rees, J. R.; Richter, B.; Williams, W. S. C. (Stanford Univ., Calif.). Phys. Rev. Lett., 22: 1131-4(May 26, 1969).

Cross sections for the reactions $\gamma p \rightarrow K^+\Lambda$ and $\gamma p \rightarrow K^+\Sigma^0$ were measured at squared four-momentum transfer $(-t)$ from 0.005 to 2 $GeV^2$, at photon energies 5, 8, 11, and 16 GeV. For $-t > 0.2$ $GeV^2$ each of the $K^+$ cross sections is about $\frac{1}{5}$ of the $\pi^+n$ photoproduction cross section, having nearly the same energy and momentum-transfer dependence. The $K^+$ cross sections fall off at small $|t|$, however, in contrast to the sharp forward spike seen in $\pi^+n$; this leads to a disagreement with an SU(3) prediction for $-t < 0.1$ $GeV^2$. The ratio of $K^+\Sigma^0$ to $K^+\Lambda$ cross sections is typically between 0.5 and 1.0. (auth)

**30697** INTERFERENCE EFFECTS PRODUCED BY SINGLE PHOTONS. Reynolds, George T. (Princeton Univ., N. J.); Spartalian, K.; Scarl, D. B. Contract AT(30-1)-3406. Nuovo Cim., 61B: 355-64(June 11, 1969).

Interference patterns produced by low-intensity photon beams passing through a Fabry–Perot interferometer were studied. Photons were detected by means of an image intensifier tube of high quantum detection efficiency. No change in the nature of the

pattern was observed when the intensity of the beam was reduced from $5 \cdot 10^4$ to 15 photons per second in the entire pattern. (auth)

**30698** ENERGY SPECTRUM OF MUONS FROM THEIR KNOCK-ON ELECTRONS. Das, A. K. (Regional Engineering Coll., Durgapur, India). Nuovo Cim., 61B: 234-40(June 11, 1969).

The energy spectrum of muons producing knock-on electrons in medium- and low-Z elements was determined. The energy of a muon can be determined from the energy it transfers to a knock-on electron and the angle which the knock-on electron makes with the direction of incidence of the primary muon. The energies of 289 and 271 incident muons producing knock-on electrons of energies greater than 25 MeV in carbon and aluminum and of 273 muons producing electrons of energy greater than 60 MeV in copper plates placed inside a counter-controlled multiplate cloud chamber, were determined. The spectrum of muons at this place is then obtained after taking into account the variation of knock-on cross-section with muon energy and integrating this cross-section over electron energy intevals ($\epsilon_{min}$ to $\infty$) considered in this experiment. The spectra of muons thus obtained compare favorably with the corresponding sea-level spectra as obtained by the Durham magnetic spectrograph. (auth)

## Weak

*Refer also to abstract 30749.*

**30699** MEASUREMENT OF THE $\Sigma^- \to ne^-\bar{\nu}$ AND $\Sigma^- \to n\mu^-\bar{\nu}$ RATES. Ang, G.; Eisele, F.; Engelmann, R. (Univ. Heidelberg). Z. Phys., 223: 103-15(1969).

Approximately $10^6$ $\Sigma^+$ decays of the stopping $K^-$ film (80 cm Saclay HBC) were measured with the Heidelberg KONRAD-system. This system is capable of detecting about 75% of the $\Sigma^- \to ne^-\bar{\nu}$ decays. In addition, about $10^6$ pictures were scanned for $\Sigma^+$ leptonic decays with secondary particle momenta below 80 MeV/c. This covers about 15% of the lepton spectrum. The data yield the following branching ratios: $[\Gamma(\Sigma^- \to ne^-\bar{\nu})]/[\Gamma(\Sigma^- \to \pi^-n)] = (1.02 \pm 0.08) \times 10^{-8}$, $[\Gamma(\Sigma^- \to n\mu^-\bar{\nu})]/[\Gamma(\Sigma^- \to \pi^-n)] = (0.43 \pm 0.06) \times 10^{-8}$. Since only a part of the lepton spectra is detected, the branching ratios depend slightly on the form of the transition matrix elements. The values quoted above were derived taking the Cabibbo solution $g_1/f_1 = -0.24$ and the CVC prediction $f_2/f_1 = -1.14$. The branching ratios are in good agreement with $\mu$, e universality. (auth)

## Strong (Baryon-Induced)

*Refer also to abstracts 30719 and 30723.*

**30700** (SLAC-Trans-95) ELASTIC p-$^4$He BACKWARD SCATTERING AT 665-MeV PROTON ENERGY. Komarov, V. I.; Savchenko, O. V. ([Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems]). Translated by T. Watt for Stanford Linear Accelerator Center, Calif., from report JINR-P1-3720. 16p. Dep. CFSTI.

The differential cross section of 665-MeV proton elastic scattering by $^4$He nuclei at an angle of 169° (cms) was measured by the scintillation counter method. The obtained value of $(1.2 \pm 0.3) \cdot 10^{-31}$ cm$^2$ ster.$^{-1}$, corresponding to 9.5 f$^{-1}$ momentum transfer is compared with the theoretical estimation of the probability of such scattering based on the idea of nuclear matter density fluctuations. (auth)

**30701** PION-PION CORRELATIONS AT LOW ENERGIES. Clayton, J. (Univ. of Liverpool); Mason, P.; Muirhead, H.; Renton, P.; Rigopoulos, R.; Tsilimigras, P.; Vayaki-Serafimidou, A. Nuovo Cim., Lett., 1: 779-83(May 21, 1969).

The discrepancies between phase space fits and histograms for $\pi\pi$ effective-mass distributions in the region of low $\pi\pi$ mass in the region of low $\pi\pi$ masses are illustrated using data on the annihilation interaction $p\bar{p} \to 3\pi^+3\pi^-\pi^0$ at 2.5 GeV/c together with $\chi^2$ values of the best fit as a function of pion-pion mass. The data were fitted by the maximum likelihood method with phases space plus $\rho$ and $\omega$ resonances added incoherently. A number of experiments were examined, where the final states contained many pions in a system of restricted total energy. (L.B.S.)

**30702** INELASTIC np INTERACTIONS AT ENERGY FROM 2 UP TO 10 GeV. NEUTRON BOMBARDMENT, NEUTRON SPECTRUM AND CROSS SECTIONS OF VARIOUS REACTIONS. Moroz, V. I.; Nikitin, A. V.; Troyan, Yu. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 792-7 (Apr. 1969). (In Russian).

Methods to determine the spectrum of neutrons emitted under the zero angle to the proton trajectory inside the JINR synchrotron are described. Effective cross sections of various channels of the np interactions are determined. (auth)

**30703** SELECTION OF pN INTERACTIONS FROM THE GRAY TRACK IN NUCLEAR EMULSIONS. Galstyan, D. A. Yadern. Fiz., 9: 805-8(Apr. 1969). (In Russian).

24 GeV/c proton interaction with free and quasifree nucleons of the emulsion nuclei were studied from the point of view of secondary particle interaction inside the nucleus. It is established that the star without a gray track best corresponds to the pN interactions while stars with gray track contain the admixture of events due to internal nuclear cascade. (auth)

**30704** PRODUCTION OF LOW-MASS $p\pi^+\pi^-$ AND $\bar{p}\pi^+\pi^-$ STATES IN THE REACTION $\bar{p}p \to \bar{p}p\pi^+\pi^-$ AT 3 TO 4 GeV/c. Ferbel, T.; Holmes, R.; Stone, S. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 22: 1141-2(May 26, 1969).

Low-mass enhancements observed in the $p\pi^+\pi^-$ and in the $\bar{p}\pi^+\pi^-$ systems produced in the reaction $\bar{p}p \to \bar{p}p\pi^+\pi^-$ at 3 to 4 GeV/c are discussed. It is concluded that these enhancements near the mass of the N(1470), at this energy, are associated with the $\Delta^{2+}(1236)$-$\bar{\Delta}^{2-}$ (1236) channel. (auth)

**30705** NUCLEAR STRUCTURE USING THE PARTICLES OF HIGH-ENERGY PHYSICS. I. De-Shalit, A. Comments Nucl. Particle Phys., 3: 42-7(Mar.-Apr. 1969).

Elementary particle reactions with complex nuclei are considered. For high-energy physics studies the nucleus provides a target with more convenient quantum numbers, whereas for nuclear studies the shell structure can be determined. A brief review is given of the research in both nuclear and high-energy physics using the nucleus as a target. (J.F.P.)

**30706** HIGH ENERGY PHYSICS (INTRODUCTION). Leprince-Ringuet, Louis (College de France, Paris. Ecole Polytechnique, Paris). Ind. At., 13: Nos. 3-4, 35-40(1969). (In French).

The review of high-energy physics covers nuclear physics and cosmic mesons, the coming of accelerators, antinucleons, large synchrotrons, and particles with very short lifetimes. (J.F.P.)

**30707** FORMATION OF A MESONIC STATE IN THE $\bar{p}p$ INTERACTION AT 1.32 GeV/c. Kalbfleisch, G.; Strand, R.; Vanderburg, V. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett., 29B: 259-62(May 12, 1969).

In a bubble chamber experiment, the reaction $\bar{p}p \to \rho^0\rho^0\pi^0$ is found, only at 1.33 ± 0.02 GeV/c, with a cross section of 0.5 ± 0.1 mb. This effect is attributed to the formation of an $I^G = 1^-$ state, $\pi(2190) \to \rho^0\rho^0\pi^0$. (auth)

**30708** SEARCH FOR HEAVY MASS PARTICLES IN THE SEA LEVEL COSMIC RADIATION. Ashton, F.; Edwards, H. J.; Kelly, G. N. (Univ. of Durham, Eng.). Phys. Lett., 29B: 249-51 (May 12, 1969).

The results of a search for low velocity ($\beta < 0.9$) heavy-mass particles in the sea level cosmic radiation are described. Two particles of charge e and rest mass (1.9 ± 0.5) GeV/c$^2$ and (2.5 ± 0.5) GeV/c$^2$ were detected at a low flux level. The most likely interpretation of these events is that they are deuterons. (auth)

**30709** SEARCH FOR THE PARTICLES WITH FRACTIONAL CHARGES (QUARKS) AT IHEP 70 GeV ACCELERATOR. Antipov, Yu. M.; Karpov, I. I.; Khromov, V. P.; (and others) (Inst. for High Energy Physics, Serpukhov, USSR). Phys. Lett., 29B: 245-8(May 12, 1969).

The results of an experiment searching for quarks with charge from $\frac{2}{3}e$ to $\frac{1}{3}e$, that are generated by 70-GeV protons on the Al target at zero angle, are reported. In the range of masses available at the IHEP accelerator quarks were not found. The upper limit estimation of the differential cross section of quark production with mass $\lesssim 5$ GeV/c$^2$ and the charge $\frac{2}{3}e$ equals to $7\text{-}9 \times 10^{-36}$ cm$^2$/ster GeV/c (90% confidence level). Total cross section of quark production with charge $\frac{2}{3}e$ and mass 4.5-5 GeV/c$^2$ does not exceed $4 \times 10^{-37}$ cm$^2$. (auth)

**30710** $K_1^0K_1^0$ ENHANCEMENTS AS OBSERVED IN ANNIHILATIONS OF SLOW ANTIPROTONS IN HYDROGEN. Aguilar-Benitez, M. (CERN, Geneva); Barlow, J.; Jacobs, L. D.; Malecki, P.; Montanet, L.; d'Andlau, Ch.; Astier, A.; Cohen-Ganouna, J.; Della Negra, M.; Loerstad, B. Phys. Lett., 29B: 241-4(May 12, 1969).

Experimental results are presented and discussed for the

$K_1^0K_1^0$ system threshold, with evidence for the presence of the S* and the $f^0$ mesons. (auth)

### Strong (Meson-Induced)

*Refer also to abstracts 30706, 30707, 30723.*

**30711** (CEA-R-3468) STUDY OF THE $A_1$, $A_2$, AND OF OTHER MESONIC STATES IN $\pi^-p$ INTERACTIONS AT 11 GeV/c. Kochowski, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1969. 95p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

Study of the $\pi^-p$ interactions with at least four bodies in the final states at 11 GeV/c was carried out in the 1.50-m British and in the 2-m CERN liquid hydrogen bubble chambers at the CERN proton synchrotron. One observes a production of the $A_1^-$ in the $\rho^0\pi^-$ decay mode, of the $A_2^-$ in the $\rho^0\pi^-$ and $\eta\pi^-$ modes, and of the $A_3^-$ in the dominant $f^0\pi^-$ mode. For the $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ reaction, the validity of the one-pion-exchange model, which allows the estimation of the background under the A enhancements produced in this reaction was checked. (auth)

**30712** FORMATION OF N*(3,3) ISOBARS IN THE $\pi^-p \rightarrow \pi^+\pi^-n$ REACTION. Komar, A. P.; Makarov, M. M.; Sarantsev, V. V.; Gasilova, N. S. (Ioffe Inst. of Physics and Tech., Leningrad). Dokl. Akad. Nauk SSSR, 184: 584-7(Jan. 21, 1969). (In Russian).

The $\pi^-p \rightarrow \pi^+\pi^-n$ reaction, chosen for analyzing the N*(3,3) isobar, is well suited for this purpose because the probability of creating a "pure" (3,3) ($\pi^-n$) state is an order of magnitude higher than that of the ($\pi^+n$) state. This is due to the fact that in the energy range in question the reaction goes fundamentally from the ground state with an isotopic spin $T = \frac{1}{2}$. The amplitude of formation of the isobar N* is the most important feature needed for the wave analysis of the reaction and for comparing it with the predictions of the theory based on various groups of symmetry. The isobar amplitudes were determined by analyzing the experimentally determined distribution of the squares of effective ($\pi^-n$) masses, taking care not to distort the effects due to the interference of ($\pi N$) and ($\pi\pi$) in the final state. Results of the phase analysis explained the angular distribution of $\pi^+$ mesons by the 3 waves corresponding to the s, p, and d formation of the isobar, although the s-formation of the isobar up to energies of 450 to 500 MeV is obviously quite small. (TTT)

**30713** PION BACKWARD ELASTIC SCATTERING ON NEUTRONS IN THE REGION 1.5 TO 3.8 GeV/c. Antopolskii, V. D.; Bayatyan, G. L.; Brakhman, E. V.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 9: 798-804(Apr. 1969). (In Russian).

Backward elastic $\pi^-n$ scattering was studied in the region 1.5 to 3.8 GeV/c. Background scattered pion was registered in spark chambers surrounding the liquid deuterium target. Forward scattered neutron was registered in spark chambers of the neutron detector. Measuring the angle of the backward scattered pion and the interaction pion t of the recoil neutron, the kinematics of elastic event could be determined. The data on the dependence of differential cross section on the energy in the region 1.5 to 3.8 GeV/c and the angular distributions for $-0.93 > \cos\theta^* > -1$ are presented. (auth)

**30714** ON THE $g^0$ RESONANCE DECAY INTO FOUR PIONS. Vetlitskii, L. A.; Guzhavin, V. M.; Kliger, G. K.; Kolganov, V. Z.; Lebedev, A. V.; Lomkatsi, G. S.; Nilov, A. F.; Smolyankin, V. T.; Sokolov, A. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 789-91(Apr. 1969). (In Russian).

When investigating $\pi^-p$ interactions at 4.7 and 5.74 GeV/c in the ITEP 55 cm liquid hydrogen chamber the reaction $\pi^-p \rightarrow \pi^+\pi^-\pi^+\pi^-n$ was studied. In the effective mass distribution of the four pions system there is an excess of events in the region 1.65 to 1.85 GeV/$c^2$ identified as $g^0$ meson. The ratio of different decay channels of this resonance is estimated. (auth)

**30715** $\pi^-p$ CHARGE EXCHANGE AT HIGH MOMENTUM TRANSFER. Chase, R. C.; Coleman, E.; Courant, H. W. J.; Marquit, E.; Petraske, E. W.; Romer, H.; Ruddick, K. (Univ. of Minnesota, Minneapolis). Phys. Rev. Lett., 22: 1137-40(May 26, 1969).

Data are presented for the charge-exchange scattering of negative pions on protons at high momentum transfer for incident pion momenta in the range 2 to 6 GeV/c. They are compared with predictions from a Reggeized baryon-exchange model of the process. (auth)

**30716** MASS SPECTRUM OF $K^0\Lambda^0$. Demidov, V. S.; Kirillov-Ugryumov, V. G.; Nikitin, Yu. P.; Ponosov, A. K.; Protasov, V. P.; Sergeev, F. M. (Moscow Engineering-Physics Inst.). Yadern. Fiz., 9: 587-9(Mar. 1969). (In Russian).

The mass spectrum of the $K^0\Lambda^0$ system produced in the $\pi^-$-meson interactions with the light nuclei (C, F, Cl) is investigated. The experiment is performed with 3.86-GeV/c $\pi^-$ mesons. The obtained data indicate a possible existence of the resonance with mass $M \approx 1.94$ GeV and width $\Gamma \sim 100$ MeV. (auth)

**30717** $\pi^+p$ 4-PRONG INTERACTIONS BETWEEN 3 AND 4 GeV/c. Brown, David Gordon. Berkeley, Calif., Univ. of California, 1968. 172p.

Thesis.

The Lawrence Radiation Laboratory 72-inch hydrogen bubble chamber was exposed to a beam of $\pi^+$ mesons at incident momenta ranging from 2.95 to 4.08 GeV/c. The resulting film yielded 39,000 4-prong interactions which were processed using the FSD device and the Fog-Cloudy-Fair data reduction system. Formation of N*(2850) and production of the dominant quasi-two-body final states were investigated. In particular the double resonance channels $N^{*++}\rho^0$, $N^{*++}f^0$, $N^{*++}\omega^0$, and $N^{*++}\eta^0$ were sufficiently free from background to allow consideration of their production mechanisms as seen in their cross sections and angular distributions. One-meson-exchange models were found to account correctly for the general features of the first reaction although being inadequate to explain the fine structure of the experimental distributions. (Disser. Abstr.)

**30718** PRODUCTION OF A $\pi^-\eta$ RESONANCE AT A MASS OF 0.98 GeV IN $K^-n \rightarrow \Lambda\pi^-\eta$ AT 4.5 GeV/c. Miller, D. H. (Purdue Univ., Lafayette, Ind.); Kramer, S. L.; Carmony, D. D.; Eisner, R. L.; Garfinkel, A. F.; Gutay, L. J.; Yen, W. L. Phys. Lett., 29B: 255-8(May 12, 1969).

An I = 1 resonance decaying into $\pi^-\eta$, in the reaction $K^-n \rightarrow \Lambda\pi^-\eta$, ($\eta$ decaying into neutrals), at a mass of 0.98 ± 0.01 GeV with a $\Gamma$ of 60 ± 30 MeV was observed. The production cross section is (15 ± 3) $\mu$b. (auth)

**30719** $\Omega^-$ PRODUCTION IN 10 GeV/c $K^-p$ INTERACTIONS. Speth, R. Technische Hochschule, Aachen.); Schiller, H.; Bardadin-Otwinowska, M.; Mermikides, M. E.; Porth, P. Phys. Lett., 29B: 252-4(May 12, 1969).

Seven events of $\Omega^-$ production observed in 10 GeV/c $K^-p$ interactions are reported. Average values are given for $\Omega^-$ mass and life-time. Production characteristics are discussed. (auth)

## Particle Interactions and Properties (Theoretical)

*Refer also to abstracts 31059 and 31065.*

### General

*Refer also to abstracts 30837 and 30844.*

**30720** (AD-680287) HIGH-ENERGY PHYSICS. Final Scientific Report. Thirring, Walter E. (Vienna Univ. (Austria). Institut fuer Theoretische Physik). Aug. 31, 1968. Contract AF61(052)-959. 10p. (AFOSR-68-2876). CFSTI.

Research was carried out in current algebra (sum rules and the problem of gradient terms). Weak hadronic decays were computed in the quark model. Finally, quantum field theory in de Sitter space and a spin-wave formulation of the BCS-model are studied. (auth)

**30721** (AD-683566) PRODUCT STRUCTURE OF MEASUREMENTS. Research Communication No. 88. Jacobson, Donald A. (Douglas Aircraft Co., Inc., Huntington Beach, Calif. Advanced Research Lab.). Dec. 1968. 32p. CFSTI.

In particle momentum measurements, loosely speaking, the result of a multiparticle measurement is the direct product of the result of several single-particle measurements. This built-in product structure for particle momentum measurements forms the basis for a simple presentation of the decomposition principle or cluster structure of the S-matrix. Previously the formulation of an S-matrix theory valid for arbitrary measurements was begun. To introduce the decomposition principle into this theory, it is first necessary to investigate the product structure of arbitrary measurements. The fundamental properties of such a product structure are derived from a postulate describing the way two states can be combined to form a single compound state. (auth) (USGRDR)

**30722** (ISS-68/39) SOTTOSEZIONE SANITA OF THE INFN. Progress Report for the Period July 1, 1967-June 30, 1968.

(Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Oct. 22, 1968. 21p. (In Italian). Dep.

This report deals with the activities of the "Sottosezione Sanità" of the INFN for the period: July 1, 1967 to June 30, 1968. Research work in the fields of elementary particle physics, nuclear physics, solid state physics and electromagnetic interactions is described. A brief account of the activities of the Computing Centre is also given. (auth)

**30723** (NYO-3178-6) RESEARCH IN ELEMENTARY PARTICLE PHYSICS. Technical Progress Report, May 31, 1969. Kirsch, Lawrence; Schnitzer, Howard J. (Brandeis Univ., Waltham, Mass. Dept. of Physics). Contract AT(30-1)-3178. 11p. Dep. CFSTI.

Research performed on both theoretical and experimental physics is described. This research is either previously published or is under analysis and includes a study of $S = -1$ baryons in the range 1600 to 1740 MeV, search for the kappa meson, $\Xi^*$ production, the reactions $K^- + p \rightarrow \Sigma^+ + 4\pi$, $K^- + p \rightarrow \Lambda + 5\pi$, and $K^- + n \rightarrow \Sigma^- + \eta^0$, the Ward identity for current algebra, transverse parts of current algebra amplitudes, and current algebra at short distances. (J.F.P.)

**30724** GAUGE FIELDS AND THE ALGEBRA OF POLARIZATIONS. Ingraham, R. L. (New Mexico State Univ., Las Cruces). Nuovo Cim., 61A: 73-82(May 1, 1969).

Rigorous c-number solutions of the source-free (but nonlinear because of the curvature tensor) field equations of a gauge field $B_\mu$ for the local group G are found. The polarization matrices are forced thereby to satisfy a Lie algebra. If this is Abelian, one gets the usual gauge-field theory, with any Lie group G desired. In the non-Abelian case, some curious new features emerge. The polarizations turn out to be the generators of the little group of a timelike momentum, and G is fixed as a group containing the homogeneous Lorentz group L. If one uses these well-determined polarizations to build the interaction-picture quantized gauge field, and requires G to be "internal" (i.e., to commute with the "external" Poincaré group), then a continuous infinity of independent polarization states are required, even though as a group-theoretical object $B_\mu$ belongs to the mass >0, spin-1 representation space. Interpreting $B_\mu$ as $W_\mu$, the intermediate boson, one gets an effective current-current interaction invariant against this internal Lorentz group which, since $SU_3 \not\supset L$, breaks $SU_3$ in a specific way. (auth)

**30725** ELEMENTARY PARTICLE THEORY. RELATIVISTIC GROUPS AND ANALYTICITY. Proceedings of the Eighth Nobel Symposium held May 19–25, 1968 at Aspenaesgarden, Lerum, in the County of Aelvsborg, Sweden. Svartholm, Nils (ed.). Nobel Symposium 8. New York, John Wiley and Sons, Inc., 1968. 399p. $31.75. (CONF-680519).

The conference included 23 papers. Separate abstracts were prepared for all papers. (J.F.P.)

*For abstracts of individual papers see: 30726, 30734, 30739, 30758, 30777–30779, 30784–30787, 30799–30805, and 30831–30835.*

**30726** ANALYSIS OF THE GELL-MANN–DASHEN ANGULAR MOMENTUM CONDITION FOR THE ISOSPIN-FACTORED CASE. O'Raifeartaigh, L. S. (Inst. for Advanced Study, Princeton, N. J.). pp 257-62 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

Starting with SU(2) current algebra some partial results for the angular momentum condition in the isospin-factored case are given. Also the problem of space-like solutions is mentioned. (J.F.P.)

## Electromagnetic

*Refer also to abstracts 30371, 30373, 30374, 30694, 30739, and 30835.*

**30727** DOUBLE LOGARITHMIC ASYMPTOTICS OF $e^+e^-$ ANNIHILATION INTO ARBITRARY NUMBER OF PHOTONS. Gorshkov, V. G.; Lipatov, L. I. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 9: 818-31(Apr. 1969). (In Russian).

Double logarithmic asymptotics of the amplitude of $e^+e^-$ annihilation into three and more photons is found. Analytical expressions for the annihilation cross sections into a definite number of photons polarized in the plane of the four-momenta charged particles and normal to it, are given. The total annihilation cross section into infinite number of photons is obtained. The formula of the annihilation cross section into three unpolarized photons is given. (auth)

**30728** PHOTON CIRCULAR POLARIZATION IN THE REACTION $e^+e^- \rightarrow \pi^+\pi^-\gamma$ AND THE PHASE OF THE PION FORM FACTOR. Kondratyuk, L. A.; Ponomarev, L. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 9: 832-7(Apr. 1969). (In Russian).

Circular polarization $P_\gamma$ of the soft $\gamma$ quantum normal to the plane that contains momenta of the electron and of one of the pions in the reaction $e^+e^- \rightarrow \pi^+\pi^-\gamma$, is calculated. It is shown that measuring $P_\gamma$ for soft quanta the phase of the pion form-factor can be determined, which, in the region of mass of the pair $\pi\pi$ from $2m_\pi$ up to $4m_\pi$, coincides with the P wave phase shift for the $\pi\pi$ scattering. The cross section which is necessary to measure is of the order of $10^{-34}$ to $10^{-35}$ cm$^2$ while the circular polarization in this case is about 10 to 15%. (auth)

**30729** TOTAL CROSS SECTIONS OF CHARGED PION PHOTOPRODUCTION ON NUCLEONS NEAR THRESHOLD. Adamovich, M. I.; Larionova, V. G.; Kharlamov, S. P.; Yagudina, F. R. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 9: 848-51 (Apr. 1969). (In Russian).

Total cross sections of photoproduction of charged pions on nucleons in the photon energy region 160 to 230 MeV are given. The threshold values of the photoproduction amplitudes obtained from extrapolation of the experimental data are in good agreement with the values calculated using the PCAC theory. Renormalized coupling constant of the axial–vector current is estimated as $g_A/g_V = 1.21 \pm 0.02$ from the threshold value of the photoproduction amplitude of positive pions on protons. (auth)

**30730** ON NECESSITY OF NEW MEASUREMENTS OF SPIN-PARITY OF $X^0$ (960) MESON. Zaslavskii, A. N.; Ogievetskii, V. I.; Tybor, V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 852-6(Apr. 1969). (In Russian).

It is shown that contrary to the widespread opinion, one cannot state on the basis of existing experimental data that $X^0$ (960) meson is pseudoscalar, spin-parity $2^-$ seems to be even more preferable. In this case the pseudoscalar meson nonet would contain E(1420) meson, in accordance with the prediction of broken $SU(6)_W$. A method to solve the alternative for $X^0$ meson, $2^-$ or $0^-$, by means of the measurement of the $X^0$ decay width into two photons and of the $X^0$ production cross section in the Primakoff effect is proposed. (auth)

**30731** LOWER BOUND FOR DECREASE OF FORM FACTORS. Volkov, G. G.; Ezhela, V. V.; Mestvirishvili, M. A. (Inst. of High-Energy Physics, Moscow). Yadern. Fiz., 9: 857-61(Apr. 1969). (In Russian).

Lower bound for decrease of formfactors in the region of large momentum transfer is established. Exponential character of decrease of electromagnetic formfactors of pions and nucleons is estimated. (auth)

**30732** PHOTOPRODUCTION AND ELECTROPRODUCTION OF PIONS IN POLARIZED-PROTON TARGETS. Zagury, N. (Univ., Catolica, Rio de Janeiro, Brazil); Teixeriira, A. F. F. Nuovo Cim., 61A: 83-97(May 1, 1969).

The angular distribution of pions for photoproduction and electroproduction of pions in polarized-proton targets is given. Using explicit values for the multipoles this angular distribution was calculated in the case where the energy of the $\pi$-$\mathcal{N}$ system in their center of mass is 1236 MeV and for momentum transfers equal to zero (photoproduction) and –3, –6 and –10 fm$^{-2}$ (electroproduction). (auth)

**30733** QUARK MODEL AND THE MAGNETIC MOMENTS OF PROTON AND NEUTRON. Gell, Y.; Lichtenberg, D. B. (Tel-Aviv Univ., Israel). Nuovo Cim., 61A: 27-40(May 1, 1969).

It is shown that in order to obtain agreement with experiment for the ratio of the proton to neutron magnetic moment within the framework of the nonrelativistic quark model, the nucleon wave functions must contain orbital angular momentum. Any departure from $SU_6$-invariant wave functions for proton and neutron not containing orbital angular momentum only enlarges the disagreement with experiment. (auth)

**30734** MEASUREMENT OF THE NUCLEON AXIAL-VECTOR FORM FACTOR. Adler, Stephen L. (Inst. for Advanced Study, Princeton, N. J.). pp 263-8 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

Four methods for measuring the nucleon axial-vector form

factor are briefly discussed. These methods include $\nu$ + N and e + N interactions. (J.F.P.)

**30735** ASYMPTOTIC BEHAVIOR OF ELECTROPRODUCTION STRUCTURE FUNCTION. Brandt, Richard A. (Univ. of Maryland, College Park). Phys. Rev. Lett., 22: 1149-51(May 26, 1969).

The electroproduction function $F_2(-\nu/q^2)$, defined as the limit of the structure function $\nu W_2(q^2, \nu)$ for $\nu \to \infty$, $\nu/q^2$ fixed, is experimentally observed to approach a constant for $-\nu/q^2 \to \infty$. This result is derived from an integral representation of the scattering amplitude and the assumption of Regge behavior for the limit $\nu \to \infty$, $q^2$ fixed. (auth)

**30736** CONSIDERATIONS ON THE CLASSICAL SPINNING ELECTRON. Cohn, Jack. (Univ. of Oklahoma, Norman). J. Math. Phys. (N. Y.), 10: 799-805(May 1969).

The asymptotic properties of the field radiated by a classical spinning (and nonspinning) point charge in arbitrary motion are considered. It is demonstrated that the expression found for the radiated angular momentum is satisfactory in that it is a 4-tensor which is spacelike surface-independent. The angular-momentum radiation rate is then expressed in terms of the retarded kinematic properties of the particle. In addition, a "center-of-energy" theorem is proved for nonspinning charges in arbitrary motion—a result which follows from the demonstrated result that nonspinning charges also radiate angular momentum. Finally, it is demonstrated that the (linear) energy–momentum radiation rate is independent of the spin of the involved charge. The discussion is manifestly covariant throughout and many mathematical details are deferred to appendices. (auth)

**30737** MAGNETIC DIPOLE MOMENT OF THE DEUTERON AND THE D*-STATE COMPONENTS. Kisslinger, L. S. (Case Western Reserve Univ., Cleveland). Phys. Lett., 29B: 211-12 (May 12, 1969).

The magnetic dipole moment of the deuteron is calculated with baryon resonances in the ground state, as estimated from high-energy proton deuteron scattering. It is shown that corrections to the traditional result can be obtained of the order of magnitude to explain the present discrepancy. (auth)

**30738** CHARGED PION PHOTOPRODUCTION AND FINITE ENERGY SUM RULES. Jackson, J. D.; Quigg, C. (Univ. of California, Berkeley). Phys. Lett., 29B: 236-40(May 12, 1969).

The large s, small t pion photoproduction data and the corresponding continuous moment sum rules are fitted with evasive Regge poles and associated Regge cuts, instead of the commonly accepted pion conspiracy. The FESR actually yield the real parts of the photoproduction amplitudes, essentially independent of the model. A further assumption permits the prediction (in good agreement with existing data) of high energy cross sections directly from the FESR, without commitment to any particular model. (auth)

## Weak

*Refer also to abstracts 30720, 30734, and 30991.*

**30739** WEAK AND ELECTROMAGNETIC INTERACTIONS. Salam, Abdus (Imperial Coll. of Science and Tech., London. International Centre for Theoretical Physics, Trieste, Italy). pp 367-77 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

The synthesis between electromagnetism and the weak interactions is considered from the point of view of renormalization theory. Leptonic interactions are discussed. (J.F.P.)

**30740** ON 2 TO 30 GeV W-BOSON PRODUCTION IN A NEUTRINO BEAM. Berkov, A. V.; Bunatyan, G. G.; Zhizhin, E. D.; Nikitin, Yu. P. (Moscow Engineering-Physics Inst.). Yadern. Fiz., 9: 605-10(Mar. 1969). (In Russian).

Charged W-boson production in the reaction $\nu_\mu(\bar{\nu}_\mu) + Z \to Z + W^\pm + \mu^\mp$ on nucleons and nuclei is considered. The total cross section of the reaction is calculated in the wide region of the W-boson mass: 2 to 10 GeV in case of a nucleon target, and 2 to 30 GeV in case of a nuclear target for several values of the total magnetic moment of the W-boson. The neutrino energy is $E_\nu \leq$ 500 GeV. The formula for the threshold behavior of cross section is obtained. (auth)

## Strong (General)

*Refer also to abstracts 30372 and 30813.*

**30741** GENERAL DISTRIBUTION OF HADRON TRANSVERSE-MOMENTUM GAUSSIAN CROSS SECTIONS THAT ARE ASYMPTOTIC EXPONENTIALS. Nieto, M. M. (Univ. of Copenhagen). Nuovo Cim., 61A: 105-13(May 1, 1969).

Reviews of elastic and inelastic hadron scattering data are discussed; they indicate ($d\sigma/dt$) is universally in the form of a superposition of Gaussians (in a transverse-momentum variable x) that is an asymptotic exponential. After discussing two previous models, the method of asymptotic expansions is used to show that a mass m, superposition $(d\sigma/dt)_m = F(x) \exp[-f(m)x^2]$ with a distribution function $G(m) \cdot \exp[-g(m)]$ will yield an asymptotic exponential in x if $g(m) = K^2/f(m)$. Experimental and theoretical implications are discussed. (auth)

**30742** DUALITY AND THE HADRON SPECTRUM. Mandula, J.; Rebbi, C.; Slansky, R.; Weyers, J.; Zweig, G. (California Inst. of Tech., Pasadena). Phys. Rev. Lett., 22: 1147-9(May 26, 1969).

A form of exchange degeneracy for mesons and baryons is derived from duality and the absence of resonances in exotic channels. The implications of this structure for the hadron spectrum are discussed. (auth)

**30743** REGGE TRAJECTORIES AND PARTICLE SIZE. Frye, Graham; Susskind, Leonard (Yeshiva Univ., New York). Phys. Rev. Lett., 22: 1145-7(May 26, 1969).

Two models of rising trajectories are contrasted. The first, based on single-channel rotational excitations, leads to a mean square particle radius which increases linearly with angular momentum for excitations on a trajectory. The second model, which makes use of a conjectured weakly violated selection rule, gives a particle radius which is constant along a trajectory. The approximate selection rule explains the narrowness of the higher resonances. (auth)

**30744** NEW l-PLANE BRANCH POINT AND THE MULTIPERIPHERAL BOOTSTRAP. Tan, Chung-i; Wang, Jiunn-ming (Princeton Univ., N. J.). Phys. Rev. Lett., 22: 1152-4(May 26, 1969).

A new type of $l$-plane branch point, heretofore unnoticed, is found, which may become more important than the Amati, Fubini, and Stanghellini branch points. When the multiperipheral bootstrap model is employed, this new type of branch point implies an asymptotic lower bound of Regge trajectories, i.e., $\alpha(t) \geq -a(-t)^{1/4}$, as $t \to -\infty$. A linear trajectory will violate this bound. (auth)

**30745** EXISTENCE OF FIREBALLS. Grigorov, N. L.; Daibog, E. I.; Rozental, I. L.; Shestoperov, V. Ya. (Moscow State Univ.). Yadern. Fiz., 9: 597-604(Mar. 1969). (In Russian).

A critical analysis is presented of principal evidence of the existence of the fireballs, collected until now. It is shown that for some total momentum distributions all of them are reasonably explained with two known properties of strong interactions at high energies: approximate independence of the distribution of secondary particle transverse momenta on the initial particle energy, and some prevalence of one of the secondary particles. (auth)

**30746** EXTRA-NUCLEAR HADRON CASCADE CALCULATIONS USING PASSOW'S APPROXIMATION. O'Brien, K. (Atomic Energy Commission, New York). Nucl. Instrum. Methods, 72: 93-8(1969).

An approximate energy-dependent solution to the coupled Boltzmann equations for energetic hadrons has been applied to measurements of the extranuclear cascade by energetic proton beams from 1 to 18 GeV. Agreement with experiment and with Monte Carlo calculations applied to these experiments is good. (auth)

## Strong (Baryon No. = 0)

*Refer also to abstract 30801.*

**30747** ON POSITIVE SPECTRAL FUNCTIONS IN THE MANDELSTAM REPRESENTATION. Martin, A. (CERN, Geneva). Nuovo Cim., 61A: 56-66(May 1, 1969).

The restrictions imposed on a neutral pseudoscalar scattering amplitude by the assumption that the double spectral function is positive are studied. It turns out that the total cross section is bounded by cost/log s, and that the Froissart–Gribov formula holds for $l > 1$. An example, nearly saturating these limitations, and such that the imaginary part of each partial-wave amplitude is within the unitarity limits, is given. (auth)

**30748** FIELD-CURRENT IDENTITY, PARTIALLY CONSERVED CURRENTS, AND THE VENEZIANO MODEL. Arno-

witt, R. (Northeastern Univ., Boston); Nath, P.; Srivastava, Y.; Friedman, M. H. Phys. Rev. Lett., 22: 1158-61(May 26, 1969).

Hard-meson partial conservation of axial-vector current and partial conservation of vector current are imposed upon the Veneziano amplitudes. It is seen that these determine inelastic amplitudes (e.g., $\pi\pi \to \pi A_1$, etc.) in terms of corresponding elastic amplitudes (e.g., $\pi\pi \to \pi\pi$). Mass formulas for the $\kappa$ and $\delta$ meson, equality of many trajectory slopes of either normality, and $\pi K$ scattering lengths are obtained, in good agreement with experiment. (auth)

**30749** VENEZIANO MODEL AND CURRENT ALGEBRA: THE HYPOTHESIS OF PARTIAL CONSERVATION OF AXIAL-VECTOR CURRENT. Schnitzer, Howard J. (Brandeis Univ., Waltham, Mass.). Phys. Rev. Lett., 22: 1154-8(May 26, 1969).

A systematic procedure for applying the hypothesis of the partial conservation of the axial-vector current to the Regge-pole models of the Veneziano type is illustrated by a discussion of the matrix element of the axial-vector current for the weak process $A_\mu + \pi \to \pi + \pi$. Additional information is obtained which relates the reactions $\pi + \pi \to \pi + \pi$ and $\pi + \pi \to \pi + A_1$. (auth)

**30750** UNITARY DYNAMICS. Johnson, Robert C. (Univ. of Toronto). Phys. Rev. Lett., 22: 1143-5(May 26, 1969).

A way to include unitarity in dynamical calculations that may involve indefinitely rising Regge trajectories is described. As an illustrative application the sigma meson in $\pi$-$\pi$ scattering is studied. (auth)

**30751** DIFFRACTION PEAK IN ELASTIC SCATTERING. Arushanov, G. G. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 5, 46-50(1968). (In Russian).

Various inequalities were obtained for elastic scattering of high-energy particles at given amplitudes of forward scattering and for total cross sections of elastic scattering. (R.V.J.)

**30752** A DYNAMICAL METHOD SATISFYING UNITARITY AND USING THE VENEZIANO MODEL. Balazs, L. A. (Imperial Coll. of Science and Tech., London). Phys. Lett., 29B: 228-9 (May 12, 1969).

A method is given which uses a relativistic equivalent potential with a cutoff approximately representing short range forces. Both potential and cutoff are determined by the Veneziano model. (auth)

## *Strong (Baryon No. = 1)*

*Refer also to abstracts 30751 and 30768.*

**30753** (NP-17839) ON THE S-TRANSFORMATION IN THE STRONG COUPLING THEORY. Exner, P. (Karlova Universita, Prague (Czechoslovakia); Tolar, J. (Technical Univ. of Prague (Czechoslovakia)). [1968]. 8p. Dep.

The S-transformation is a unitary transformation accomplishing the main part of the diagonalization of the interaction Hamiltonian in strong coupling theories. For a compact symmetry group the action of the S-transformation on the integrals of motion is derived. (auth)

**30754** (ORNL-tr-2123) STATISTICAL CALCULATIONS OF INELASTIC COLLISIONS OF FAST PARTICLES WITH INTRA-NUCLEAR NUCLEONS. Barashenkov, V. S.; Gudima, K. K.; Toneev, V. D. ([Joint Inst. of Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics)]). Translated for Oak Ridge National Lab., Tenn., from report JINR-P2-4066. 26p. Dep. CFSTI.

A discussion is given of the manner in which an accurate satisfaction of the laws of conservation of momentum and energy in forming a model of an elementary event according to the Monte Carlo method can be ensured. It is shown that not only the mean values but also the distributions of the calculated quantities are found to be in close agreement with experiments. (J.F.P.)

**30755** ON THE PARAMETRIZATION OF PION NUCLEON SCATTERING AMPLITUDE AT ENERGIES LESS THAN 2 GeV. Abul-Magd, A. Y. (International Centre for Theoretical Physics, Trieste, Italy); Alberi, G. Z. Phys., 223: 162-8(1969).

The pion nucleon elastic scattering amplitude is parametrized as a function of the momentum transfer for $\cos\theta_{cm}$ between 1 and 0.5 and for pion laboratory energies less than 2 GeV. The variation of the parameters with that of the incident energy is discussed. (auth)

**30756** RELATIVISTIC MODEL OF S AND P WAVES IN $\pi$N SCATTERING. Vall, A. N. (Inst. of Mathematics and Computer Center, Novosibirsk, USSR). Yadern. Fiz., 9: 862-7 (Apr. 1969). (In Russian).

A set of equations is proposed for S and P waves of $\pi$N scattering with account of relativistic corrections. The set is investigated in the $\delta$ approximation and with assumption of the 33-resonance dominance. (auth)

**30757** VIRTUAL DIFFRACTION AND THE REACTION $K^-p \to \bar{K}^{*0}\pi^-p$. I. Schonfelder, J. L. (Imperial Coll., London. Univ. of Birmingham, Eng.). Nuovo Cim., 61A: 114-22(May 1, 1969).

Detailed calculations of the "Deck" virtual-diffraction background suggestion are presented, at 6 and 10 GeV/c, for the reaction $K^-p \to \bar{K}^{*0}\pi^-p$ and compared with experiment. (auth)

**30758** DISPERSION SUM RULES AND LOW ENERGY LIMITS. Fubini, S. (Massachusetts Inst. of Tech., Cambridge. Univ., Turin). pp 245-55 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

Some of the results obtained using current algebra are considered from a unified point of view. The commutator between two axial charges is discussed in detail. A sum rule is obtained which is directly related to the low-energy limit for pion-nucleon scattering. Finally, the frame dependence of the sum rules obtained by saturating equal-time commutators in different frames is considered. (J.F.P.)

**30759** THE OVERLAP FUNCTIONS FOR $\pi$p INELASTIC PROCESSES AND THEIR RELATION TO PARTIAL INELASTIC CROSS SECTIONS. Stroynowski, R. (Warsaw Univ.). Acta Phys. Pol., 35: 839-47(May 1969).

The overlap function formalism is extended to the spin $(0,\frac{1}{2})$ case. Two overlap functions for inelastic collisions—helicity nonflip and helicity flip—are introduced, the first corresponding to that from a spinless case. Their connection with partial cross sections is derived. It is shown that the slope of the helicity nonflip overlap function practically does not depend on energy in the range from 1.5 to 8 GeV/c. (auth)

**30760** A DOUBLE-REGGE ANALYSIS OF THE REACTION $K^-p \to K^-\omega p$. Ranft, G. (Rutherford High Energy Lab., Chilton, Eng.); Turnbull, R. Nuovo Cim., 61B: 317-30(June 11, 1969).

The reaction $K^-p \to K^-\omega p$ is analyzed at 6 GeV/c with a modified double-Regge model. The model compares well with the measured single-particle distributions, momentum transfer distributions and various angular correlations like Jackson angles, Treiman-Yang angles and Toller angles. (auth)

**30761** DOUBLE REGGE POLE EXCHANGE AND $K^-p$ BACKWARD SCATTERING. Michael, C. (Univ. of Wisconsin, Madison). Phys. Lett., 29B: 230-2(May 12, 1969).

An estimate of the double Regge exchange contribution to $d\sigma/du$ $(K^-p)$ at $u = 0$ suggests that a break in the energy dependence from the presently observed $s^{-10}$ behavior to an $s^{-3}$ behavior should occur at about 5 GeV/c. Further tests of the model are discussed. (auth)

## *Strong (Baryon No. ≥ 2)*

*Refer also to abstracts 30751, 30754, and 31056.*

**30762** (CONF-690503-1) PHENOMENOLOGICAL A-N POTENTIALS AND A BINDING IN NUCLEAR MATTER. Ram, B. (New Mexico State Univ., Las Cruces). [1969]. 13p. Dep. CFSTI.

From International Conference on Hypernuclear Physics, Argonne, Ill.

Effective central, spin-dependent S-wave $\Lambda$-N potentials of a variety of shapes that fit the previous scattering lengths ($a_s = -1.8$F, $a_t = -1.6$F) are constructed. These potentials, assumed to be appropriate in all angular momentum states, are then used to: calculate the binding energy of the $\Lambda$ particle in nuclear matter by the method of independent pair approximation and study its variation with various parameters; calculate the $\Lambda$-N total scattering cross sections in order to estimate the percent reduction of the potentials in odd-parity states that fit the $\Lambda$-p scattering data, previously found, and their dependence of the type of potential; and then to obtain an approximate measure of the noncentral components in the $\Lambda$-N interaction. (J.F.P.)

**30763** (ITF-69-8) METHOD OF SEPARABLE EXPANSION OF TWO-PARTICLE t-MATRIX AND THREE-BODY PROBLEM. Kharchenko, V. F.; Petrov, N. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 32p. (In Russian). Dep.

The three-body problem for the case when the total energy of the three-nucleon system is negative, is treated by means of separable expansions of a two-particle t-matrix. By expanding the wave function of system in the angular functions the Fadeyev equations are reduced to an infinite system of bound homogeneous integral equations which can be cut short in case of forces with a finite radius of action. The system of three identical spinless particles and that of three nucleons is considered. For the case of Hulten's local potential the binding energies of the triton and neutron-deuteron scattering are calculated. (auth)

**30764** (ITF-69-19) THE THREE-BODY PROBLEM WITH THE POTENTIAL OF RECTANGULAR FORM (SHAPE). Kharchenko, V. F.; Storozhenko, S. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 12p. (In Russian). Dep.

A consideration of the three-nucleon problem, based on the method of separable expansion of the two-particle t-matrix (the Hilbert–Schmidt expansion), is carried out. The treatment is performed for the case of the intraparticle interaction being characterized by a central potential of the rectangular form. The binding energy of the triton and the scattering lengths of the neutron on the deuteron are calculated. (auth)

**30765** (JINR-P2-4402) INELASTIC INTERACTIONS OF HIGH-ENERGY PROTONS WITH ATOMIC NUCLEI. Barashenkov, V. S.; Gudima, K. K.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 25p. (In Russian). Dep.

The Monte-Carlo method is used to calculate the intranuclear cascades initiated by protons of an energy from a few dozens of MeV to about 30 GeV. The law of energy-momentum conservation and the meson production processes are exactly taken into account. The evaporation from excited residue-nuclei is calculated. In the whole energy range from a few dozens of MeV to about 5 GeV the results of calculations are in good agreement with experiment; at higher energies there appear noticeable discrepancies in the characteristics of the low-energy component of produced particles. These discrepancies grow with increasing energy of the primary nucleon. An analogous disagreement between the experimental results and those obtained by the usual cascade theory appears in the case of pion-nuclear interactions. (auth)

**30766** (ORNL-tr-1934) CALCULATION OF THE INELASTIC INTERACTION OF COSMIC NUCLEI. Barashenkov, V. S.; Gudima, K. K.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). [Lab. of Theoretical Physics]). Translated by K. S. Warren, Martha Gerrard, and George E. Moore (Oak Ridge National Lab., Tenn.), from report JINR-P2-3507. 4p. Dep. CFSTI.

Deuteron–nucleus reactions were studied. Calculations were carried out using the Monte Carlo method within the framework of a cascade-evaporation model taking into account stripping and Coulombic and diffractive spallation. Some results are given. (J.F.P.)

**30767** STRONG-ABSORPTION MODEL AND OPTICAL MODEL. Faucher, G. (Laboratoire de Physique Generale, Paris). Nuovo Cim., 61A: 20-6(May 1, 1969).

The strong-absorption model is applied to 3 GeV/c proton and antiproton scattering in nuclear emulsions. The nucleon-nucleus potential is calculated and agrees with that found in the eikonal approximation with a square potential. (auth)

**30768** ELASTIC $\pi p^-$ AND pp-INTERACTIONS AT HIGH ENERGIES. Azimov, S. A.; Arushanov, G. G.; Gulyamov, U. G.; Yuldashev, A. A. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 5, 38-42(1968). (In Russian).

Phenomenological methods and correlations of various relations are used for the analysis of elastic scattering of strongly interacting, high-energy particles. (R.V.J.)

**30769** CONTRIBUTION OF $\pi$ BRANCHING TO THE AMPLITUDE OF np CHARGE EXCHANGE. Pantskhava, G. V. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR, 53: 561-4(Mar. 1969). (In Russian).

The contribution of $\pi$-branching to the amplitude of np charge exchange is studied. The experiment shows that the contribution of the poles $\rho$ and R to the amplitude at zero transferred momentum is extremely small. Hence, the necessity to take branching into account. The most essential contribution is made by $\pi$-branching and its consideration gives good agreement with experiment. (auth)

**30770** PARITY-VIOLATING INTERNUCLEON POTENTIAL AND THE FIELD-CURRENT IDENTITY. Olesen, P.; Rao, J. S. (Univ. of Rochester, N. Y.). Phys. Lett., 29B: 233-5(May 12, 1969).

The parity-violating internucleon potential arising from $\rho$, $\omega$ and $\phi$ exchange is shown to be negligible using the field-current identity (vector-meson dominance). The implications of this result are discussed. In particular, it is pointed out that from an experimental point of view the process $n + d \rightarrow {}^3He + \gamma$ should be more interesting than the process $n + p \rightarrow d + \gamma$. (auth)

**30771** STUDY OF THE HYPERTRITON WITH REALISTIC LOCAL n-p POTENTIALS. Panattoni, L. (Univ., Pisa, Italy); Rosati, S. Nuovo Cim., 61B: 425-38(June 11, 1969).

The structure of the hypertriton was studied when the n-p interaction is described by one of the most modern potentials. The radial-wave function of the n-p system is calculated by solving two coupled differential equations completely similar to those of the deuteron. The $\Lambda$-$\mathcal{N}$ interaction is described by purely central potentials with hard core derived from the analysis of light hypernuclei or from $\Lambda$-p elastic scattering. It is shown how one can correct the results obtained from the study of the hypertriton by using purely central n-p potentials: these latter, however, for hard-core radius values between 0.3 and 0.6 fm give a satisfactory approximation to the more realistic case examined here. (auth)

# Particle Invariance Principles and Symmetries

## General

*Refer also to abstracts 30804 and 30826.*

**30772** (IS-T-276) NEW APPROACH TO REPRESENTATIONS OF THE LORENTZ GROUP. Greiman, William Henry (Ames Lab., Iowa). Feb. 1969. Contract W-7405-eng-82. 61p. Dep. CFSTI.

Thesis.

Representations of the Lorentz group in bases labeled by the conformal group and the rotation group are considered. The transformation coefficients connecting the rotation group and conformal group bases are derived. These coefficients together with an Iwasawa decomposition of the Lorentz group, which implies that any Lorentz transformation may be decomposed into the product of a conformal group element and a rotation, are used to obtain representations of the Lorentz group in a conformal group basis. Several expressions for matrix elements in a rotation group basis are derived in the more conventional Cartan decomposition of the Lorentz group. These results are applied to the problem of expanding the wave function for a particle with spin in terms of representations of the homogeneous Lorentz group. Sets of functions analogous to spherical harmonics are derived in both the conformal group and rotation group bases. (auth)

**30773** (ITF-68-15) SEMISIMPLE LIE GROUPS AND ALGEBRAS AND THEIR REPRESENTATIONS. Klimyk, A. U. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 215p. (In Russian). Dep.

The methods of group theory are very promising in physics, especially in the physics of strongly interacting particles. The exclusive role which was assigned to group theory is explained by the circumstance that symmetrical physical objects always correspond to a certain group of operations preserving this symmetry. This permits one, relying only on the abstract properties of group theory, to have some information concerning the actual object. An especially important role in physics is given to semisimple groups and their representations (finite- and infinite-dimensional). These groups are studied. The main concepts of groups are discussed. The irreducible representations of semisimple Lie algebras are considered. The properties of such representations are very similar to the properties of finite-dimensional representations. Introduction of the character of higher representations permits one to resolve the problems of decomposition of the direct product of such representations with irreducible representations, and the decompositions of the contraction of such a representation of semisimple subalgebras, the representation of which is considered. Such questions of decomposition are discussed. (J.F.P.)

**30774** CONTRACTIONS OF SYMPLETIC GROUPS. Lykhmus, Ya. (Inst. of Physics and Astronomy, Tallin, USSR). Izv. Akad. Nauk Est. SSR, Fiz. Mat. 17: 479-81(1968). (In Russian).

The method of asymptotic transitions for a variety of groups (algebras) with a given number of parameters (with the given

dimension) turned out to be very useful for the formulation and solution of the many-body problem in elementary particle theory. Previously only the contractions of unitary and orthogonal groups were described in detail. The most important contractions of the symplectic groups SP(N,R), SP(N), and SP(P,Q) are indicated. (auth)

**30775** SOME POSSIBILITIES FOR GENERALIZATION OF CONTRACTION PROCEDURE FOR ALGEBRAIC SYSTEMS. Lykhmus, Ya. (Inst. of Physics and Astronomy, Tallin, USSR). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 17: 481-3(1968). (In Russian).

It is possible that elementary particle physics can have a certain significance, not only for groups, expressing the symmetry of dynamical systems, but other algebraic systems can be more evidently and straightforwardly related to dynamics. Previously attention was given to the asymptotic transitions reflecting the asymptotic relations among dynamical physical theories. Attention is given to the possibility of asymptotic transitions not only between groups (using algebras) but also between other algebraic systems. (auth)

**30776** BROKEN SYMMETRIES FOR ANY SPIN. Guralnik, G. S. (Brown Univ., Providence); Hagen, C. R. Nuovo Cim., 61A: 98-104(May 1, 1969).

It is shown that in the absence of interactions one can construct nonvanishing vacuum expectation values for the field operators which describe massless particles of an arbitrary spin. Since this necessarily implies a formal breakdown of Lorentz invariance, it might well be anticipated that the vacuum expectation value of the commutators of the canonical fields with the generators of pure Lorentz transformations could place nontrivial constraints upon the theory. However a proof is given of the fact that such commutators fail to impose any condition upon the theory and that the broken symmetry is consequently entirely self-consistent. (auth)

**30777** THE FUNDAMENTAL GROUP OF POINCARE AND THE ANALYTIC PROPERTIES OF FEYNMAN RELATIVISTIC AMPLITUDES. Regge, T. (Inst. for Advanced Study, Princeton, N. J. Univ., Turin). pp 285-309 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

The main results of investigations of the problem of characterizing the analytic properties of Feynman relativistic amplitudes are discussed. The fundamental group of Poincaré is considered by showing that it embodies the ideas of Riemann sheets with a superposed group structure. Generalities on irreducible Feynman graphs and examples of monodromy groups relative to Feynman integrals are discussed. (J.F.P.)

**30778** RELATIVISTIC GROUPS AND INFINITE-COMPONENT FIELDS. Nambu, Y. (Univ. of Chicago). pp 105-17 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

Some problems concerning the attempt to use groups and group representations for the description of particles with complex internal structure are discussed. The infinite-component wave equation, a meson model, and the application to leptons are discussed. (J.F.P.)

**30779** GROUP OF RELATIVISTIC INTERNAL MOTION, ITS UNITARY REPRESENTATION, AND WAVE EQUATION. Takabayasi, T. (Nagoya Univ., Japan). pp 157-206 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

From the general hypothesis that a particle is originally internally structured to perform quasilocal relativistic internal motion in the physical Minkowski space–time, a simple general method to describe such internal motion is formulated with the aim of application to a unified description of elementary particles. The general scheme and conception are described, and this is exemplified by several models. (J.F.P.)

**30780** ZERO-MASS REPRESENTATION OF POINCARE GROUP AND CONFORMAL INVARIANCE. Bose, S. K.; Parker, R. (Univ. of Notre Dame, Ind.). J. Math. Phys. (N. Y.), 10: 812-13(May 1969).

By explicit construction it is shown how to extend zero-mass, discrete spin representations of the Poincaré group to corresponding representations of the conformal group of Minkowski space. (auth)

**30781** APPLICATION OF THE KIRILLOV THEORY TO THE REPRESENTATIONS OF O(2,1). Dunne, S. A. (Imperial Coll., London). J. Math. Phys. (N. Y.), 10: 860-8(May 1969).

The Kirillov construction is applied to the semisimple Lie group O(2,1). All the unitary irreducible representations (except the supplementary series) are found, provided that complex subalgebras and complex points on orbits are admitted. The characters of the representations are calculated and the relation of their Fourier transforms to the orbits is examined. (auth)

**30782** NOTE ON THE TIME-REVERSAL OPERATOR. Wong, Eugene Y. (Univ. of California, Los Angeles). J. Chem. Phys., 50: 4120-1(May 1, 1969).

In considering the time-reversal operator it is shown that a factor $(-)^p$, where p is parity, should be added when the wave function is a linear combination of functions of different parity. (J.F.P.)

## Applications (Electromagnetic and Weak)

*Refer also to abstracts 30692 and 30787.*

**30783** (ITF-69-17) EQUATIONS OF MOTION IN ODD-DIMENSIONAL SPACES AND T-, C-INVARIANCE. Fushchich, V. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 13p. Dep.

The properties of the equation of Dirac type in three-dimensional and five-dimensional Minkowski space-time with respect to time reflection (in sense of Pauli and Wigner) as well as to the operation of charge conjugation are investigated. P-, T-, C-invariance of the Dirac equation for the cases of four components (in three-dimensional space) and eight components (in five-dimensional space) is established. Within the framework of the Poincaré group a relativistic equation is suggested which describes the movement of a particle with nonfixed (indefinite) mass in an external electromagnetic field. (auth)

**30784** THE PRESENT STATUS OF CP, T, AND CPT INVARIANCE. Michel, Louis (Inst. for Advanced Study, Princeton, N. J.). pp 345-65 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

A review of CP, T, and CPT invariance is presented. This review covers the history of these theories, the definition of P, C, and T, the evolution of a $K^0$ beam, $K^0$ decay, experimental data on $2\pi$ decays, and some experimental difficulties. Also included are the consequence of CPT for neutral K decays, CPT theory, and experiments for determining C, P, and T violation. (J.F.P.)

**30785** DYNAMICAL ASYMMETRY IN OCTET SPACE. Pais, A. (Rockefeller Univ., New York). pp 215-26 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

A discussion is given of the question of whether the strong symmetry breaking of SU(3) could have a dynamical origin in contradistinction to the weak and electromagnetic symmetry breaking. Consideration is given to whether, in a system with exact SU(3) symmetry acted on by electromagnetic and weak driving terms, these three forces generate a large breaking of SU(3) symmetry thereby obviating the need for the introduction of a separate medium strong interaction. Also if hadron currents which appear in semileptonic decays are octet currents, one can define a weak hypercharge which is conserved in leptonic decays in the presence of SU(3)-invariant strong interactions and electromagnetic interactions but in the absence of strong SU(3) symmetry breaking. This argument can also be extended to nonleptonic decays, in which one has a zero Cabibbo angle. It is considered whether it is possible that a fixed nonzero Cabibbo angle $\theta$ comes about as a result of weak and electromagnetic driving action so that a separate medium strong interaction need not be introduced from the outset. (J.F.P.)

## Applications (Strong)

*Refer also to abstract 30785.*

**30786** ORIGIN OF SU(3) AND ITS BREAKING, VIEWED IN LARGE-ANGLE SCATTERING. Ne'eman, Y. (Tel-Aviv Univ., Israel). pp 207-14 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

It is suggested that the current–current term in the strong interaction represents the original fundamental strong interaction and determines the direction of SU(3) breaking. This is in opposition to a spontaneous breakdown of an originally symmetric ad hoc SU(3) symmetry. (J.F.P.)

**30787** REMARKS ON THE CONNECTION BETWEEN SU(3) BREAKING AND ELECTROMAGNETIC INTERACTIONS. Cabibbo, Nicola (Univ., Rome). pp 227-43 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

The problem of the relative orientations of the strong SU(3) breaking and of weak and electromagnetic forces is considered. The computation of the weak interaction angle is discussed, and the relative direction in SU(3) space of the electromagnetic interactions and of strong SU(3) breaking forces is explained. (J.F.P.)

**30788** ON THE POSSIBILITY OF ANOMALOUSLY LARGE WIDTH IN DECAY OF E(1420) → 2γ. Zaslavskii, A. N.; Tybor, V. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., 35: 777-81(May 1969). (In Russian).

Decay E → 2γ was estimated within the limits of disturbed $SU(6)_W$ - symmetry. The width magnitude was found to be strongly related to the disturbance scheme in $SU(6)_W$ and an abnormally large width ~MeV was proven to be possible. (tr-auth)

# Field Theories

## General

*Refer to abstracts 30821 and 31090.*

## Quantum Field Theory

*Refer also to abstracts 30697, 30720, 30818, and 30842.*

**30789** (CEA-R-3763) PADE APPROXIMANTS IN FIELD THEORY: PION AND KAON SYSTEMS. Zinn-Justin, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1969. 94p. (In French). Dep. Thesis. Submitted to Univ., Paris.

The Pade approximants of the S-matrix are constructed, starting from the perturbation series, in the case of two body pion and kaon systems. These are three parameters. The seven lowest lying two body resonances ($\rho$, K*(890), $\varphi$, K*(1420), $f_0$, f', $A_2$) are obtained within a few per cent of their actual masses. The Regge trajectories are rising, the intercepts of the $\rho$ and $f_0$ agree well with the experimental values. Some properties and applications of the Pade approximants are given. (auth)

**30790** (ITF-69-9) SPECTRAL REPRESENTATIONS AND RENORMALIZATION OF SPINORIAL QUANTUM FIELDS. Medvedev, B. V.; Polivanov, M. K.; Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 9p. (In Russian). Dep.

The spectral representations of the spinorial field with possible contributions from one-particle states are successively derived. Formulas relating the mass and field renormalization constants to the integrals of two spectral densities and expressions of the vacuum expectation values for the equal-time commutators and for a one-particle matrix element are derived. (auth)

**30791** (ITF-69-20) RENORMALIZATION OF THE YANG–MILLS THEORY WITH NON-ZERO MASS. Slavnov, A. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 12p. (CONF-690417-3). Dep.

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

Renormalizability of Yang-Mills theory with arbitrary mass is established. Explicit expression for effective renormalizable Lagrangian is given. (auth)

**30792** ANALYTIC REPRESENTATION OF QUANTUM FIELD THEORY. Saraswati, D. K.; Valatin, J. G. (London Univ.). Commun. Math. Phys., 12: 253-68(1969).

The connection between a space of quadratically integrable functions of real variables q and a Hilbert space of analytic functions of complex variables z established by Bargmann is used to introduce quantized field operators for which the δ-functions of the commutation relations in q-space are replaced by analytic kernel functions in z-space, and a reference to distributions can be avoided. Bargmann's representation is first somewhat modified, so that the derivative terms in the field equations retain their form in the new representation. Local interaction terms in q-space obtain a nonlocal appearance in z-space. The transition to a 4-dimensional formulation in z-space has to resort to a Euclidean metric. The equations can be derived directly by starting from an action integral in z-space, and applying a variational calculus in which variations are restricted to analytic functions. Explicit analytic expressions are given for free field propagators. (auth)

**30793** JOST–SCHROER THEOREM FOR ZERO-MASS FIELDS. Pohlmeyer, K. (Weizmann Inst. of Science, Rehovoth, Israel). Commun. Math. Phys., 12: 204-11(1969).

The Jost–Schroer theorem is extended to zero-mass fields in one time dimension and arbitrarily many space dimensions. (auth)

**30794** BOSON FIELDS UNDER A GENERAL CLASS OF CUT-OFF INTERACTIONS. Hoeegh-Krohn, Raphael (Univ. of Oslo). Commun. Math. Phys., 12: 216-25(1969).

A boson field $\phi(x)$ under an interaction of the form $\int V(\phi_k(x))\,dx$ where $\phi_k(x)$ is the momentum cut-off field, and $V(\alpha)$ is $|x| \leq r$ a continuous bounded function. Under a weak regularity condition on $V(\alpha)$, it is proven that the total energy operator is self adjoint, that the asymptotic fields exist and that the scattering operator exists. (auth)

**30795** INFINITE RENORMALIZATIONS IN QUANTUM FIELD THEORIES. Maris, Th. A. J. (Univ. do Rio Grande do Sul, Porto Alegre, Brazil). Nuovo Cim., Lett., 1: 775-8(May 21, 1969).

An attempt is made to interpret the basic meaning of the infinite renormalization constants $Z^{-1}$ which are encountered in certain relativistic quantum field theories. It is proposed that differentiations and products of local field operators, occurring in the Lagrangian, should be reinterpreted in sense of a generalized limit. (L.B.S.)

**30796** CONDITIONS OF CAUSALITY AND LOCALITY. Slavnov, D. A. (Moscow State Univ.). Yadern. Fiz., 9: 875-81(Apr. 1969). (In Russian).

Conditions of locality and causality are considered in framework of the S-matrix approach to the quantum field theory. It is shown that these conditions may be formulated in such a way that they result in the condition of local commutativity for the Heisenberg fields and in the condition of primitive causality. (auth)

**30797** ASYMPTOTICS OF FEYNMAN GRAPHS IN SPINOR THEORY. NONPLANAR GRAPHS. Ginzburg, I. F.; Serbo, V. G. (Inst. of Mathematics and Computer Center, Novosibirsk, USSR). Yadern. Fiz., 9: 868-74(Apr. 1969). (In Russian).

A simple and convenient prescription to obtain an asymptotics for any graph with integer t-channel angular momentum from its topological structure is presented for the theory with $L_{int} = g:\bar{\psi}\gamma^\mu\psi\varphi:+h:\varphi^4:$. The dominating contribution to the asymptotics is from the two-particle unitarity. The asymptotics for the amplitudes with positive signature is determined by the planar singularities only as in conventional quantum-mechanical problem with an exchange. For the amplitudes with negative signature the nonplanar singularities determined by the spectral functions $\rho_m$ that are absent in the quantum mechanics, are also of importance. Their account may only change the degree of the logarithm in the asymptotics, as compared with that obtained from the prescription for the planar graph. Some other theories are also considered. (auth)

**30798** DYNAMICAL MASS OF ELECTRON AND RENORMALIZATION CONSTANT IN QUANTUM ELECTRODYNAMICS WITH $m_0 = 0$. Fomin, P. I.; Truten, V. I. (Physical-Technical Inst., Kharkov). Yadern. Fiz., 9: 838-47(Apr. 1969). (In Russian).

The existence of non-zero dynamical mass of the electron m in quantum electrodynamics with zero bare mass is proved. m linearly depends on the cut-off parameter Λ at a nonanalytical dependence on the physical coupling constant $\alpha$. Linear divergence of the self energy is a single real divergence of this theory. The constants $Z_1$ ($\alpha$, Λ/m) are finite and $Z_3 = 0$. So the bare charge and the bare photon do not exist. Consideration is made approximately when the whole series of terms of the type $\alpha^n \ln^n (\Lambda/m) \sim 1$ is taken into account and the terms $\alpha^n \ln^{n-1} (\Lambda/m) \ll 1$ and lower ones are neglected. (auth)

**30799** THE FUNDAMENTAL THEOREM ON THE CONNECTION BETWEEN SPIN AND STATISTICS. Sudarshan, E. C. G. (Univ. of Delhi). pp 379-86 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

A theorem within a general quantum field theory formulation

asserting the relation between spin and statistics is stated and proven. It is shown that a specific formulation of the principle of symmetry between emission and absorption processes characteristic of quantum theories already leads to the observed spin–statistics relation in all cases. In particular the theory holds for the quantum theory of tachyon fields and for more complicated wave fields which contain time-like and tachyon-like solutions. Also it holds without modification for fields which describe both positive and negative energy particles. An application is also given for nonrelativistic systems, that is, strong reflection and spin–statistics relations should apply equally well to these cases. (J.F.P.)

**30800** A NEW FORMULATION OF RELATIVISTIC QUANTUM THEORY OF FIELDS WITH APPLICATIONS TO PARTICLES TRAVELLING FASTER THAN LIGHT. Sudarshan, E. C. G. (Univ. of Delhi). pp 335-43 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

A formulation of relativistic quantum field theory which would apply uniformly to all relativistic fields is proposed. No distinction is made between positive time-like and negative time-like or space-like solutions. The formulation is extended to interacting systems, and rules for computation of the transition amplitudes are developed. This method is applied to the interactions of tachyons as well as to the discrete transformations involving time inversion. (J.F.P.)

**30801** ON THE ROLE OF UNITARITY IN FIELD THEORY. Martin, Andre (CERN, Geneva. State Univ. of New York, N. Y.). pp 311-18 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

The relations of analyticity, as obtained from field theory, with unitarity are considered. The $\pi-\pi$ system is discussed. (J.F.P.)

**30802** PROGRESS TOWARDS MODELS IN QUANTUM FIELD THEORY. Hepp, Klaus (Eidgenoessisches Technische Hochschule, Zurich). pp 269-83 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

New developments in quantum field theory are described. The $(\phi^4)_2$, $(\phi^4)_3$, $(\phi^3)_4$ and $(\Psi\Psi\phi^k)_2$ theories are discussed. Also results on cut-off theories, and the Hamiltonian $V_{00}(h) = V_{40}(h)^*$ are considered. (J.F.P.)

**30803** PROGRESS REPORT ON INFINITE MULTIPLETS. Fronsdal, C. (Univ. of California, Los Angeles. International Centre for Theoretical Physics, Trieste, Italy). pp 119-32 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

Infinite-multiplet theory is reviewed, and the field theoretic aspects are developed. (J.F.P.)

**30804** GENERAL PROPERTIES OF THE TWO-POINT FUNCTION AND INVALIDITY OF THE TCP-THEOREM FOR INFINITE-COMPONENT FIELDS. Todorov, I. T. (Joint Inst. for Nuclear Research, Dubna, USSR. Inst. of Physics, Sofia). pp 133-48 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

A concise review of recent work on general properties of the two-point function, valid for infinite-component fields, is given. A spectral representation of the two-point function is found which takes into account Lorentz invariance and spectrum conditions. It includes a decomposition of the spectral density with respect to spin. The consequences of locality are studied by means of Bogolyubov–Vladimirov's theorem. Examples are constructed showing that locality does not lead automatically to TCP invariance and that TCP does not imply even weak local (anti-)commutativity in a theory involving infinite-component fields. (auth)

**30805** INFINITE-COMPONENT FIELDS AND MASS-SPLITTING. Streater, R. F. (Imperial Coll. of Science and Tech., London). pp 149-56 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

It may be reasonable to describe a tower of particles with spins $j_0$, $j_0+1$, $j_0+2$, ..., by an infinite-component field satisfying axioms similar to the Wightman axioms. The auxiliary group technique allows one to construct free local fields, provided that all the masses are the same. Bilocal fields can be understood as a special case. It is argued that in a bilocal theory there must be infinitely many particles with each mass and spin. Moreover, it is shown that any infinite-component theory describing a particle of a certain mass must contain infinitely many other particles of the same mass. It is suggested that the finite-component irreducible tensor fields, known to describe particles of several masses and spins, could be used to describe the particles at low energy, giving a purely phenomenological theory at this energy. (auth)

**30806** PARTICLES BEYOND THE LIGHT BARRIER. Bilaniuk, Olexa-Myron (Swarthmore Coll., Pa.); Sudarshan, E. C. George. Phys. Today, 22: No. 5, 43-51(May 1969).

Properties of tachyons (particles traveling faster than light) are described using relativity theory. Also described are various experiments for the detection of tachyons. (J.F.P.)

**30807** A CLASS OF HOMOGENEOUS COSMOLOGICAL MODELS. Ellis, G. F. R.; MacCallum, M. A. H. (Dept. of Applied Mathematical and Theoretical Physics, Cambridge, Eng.). Commun. Math. Phys., 12: 108-41(1969).

Einstein's field equations are studied under the assumptions that (1) the source of the gravitational field is a perfect fluid, and (2) there exists a group of motions simply transitive on three-surfaces orthogonal to the fluid flow vector. There are two classes of solutions; these are studied in detail. Three special families of solutions examined include all analytic solutions of the field equations obeying (1) and (2) of which the authors are aware. The relation of these solutions to various vacuum solutions is indicated. (auth)

**30808** ANALYTIC REPRESENTATIONS OF TWO-POINT FUNCTIONS WITH NONCANONICAL LIGHT-CONE SINGULARITIES. I. Lukierski, Jerzy (Univ., Wroclaw). J. Math. Phys. (N. Y.), 10: 918-24(May 1969).

The classes of analytic functions describing by means of their boundary values the sets of commutator functions with singularities $\delta(\omega)(x^2)$ and $(x^2)_+^k (k = 1,2,\ldots)$ on the light cone are introduced. Their relation with the Källen–Lehmann representation having nonintegrable spectral functions is given. The generalized wave-renormalization constants, measuring noncanonical singularities, are introduced. The formulas exhibit in a clear way the light-cone behavior and provide a proper scheme for studying the equal-time limits. (auth)

**30809** MEASURE-THEORETICAL DESCRIPTION OF KLEIN–GORDON MULTIPARTICLE STATES. Prugovecki, Eduard (Univ. of Alberta, Edmonton). J. Math. Phys. (N. Y.), 10: 933-45(May 1969).

It is shown that a multiparticle state constructed from solutions of the Klein–Gordon equation can be also described by a family of complex measures having simple properties. These measures are the expectation values for that state of products of projectors corresponding to the spectral decompositions of certain self-adjoint operators. The results obtained are used in discussing the problem of defining quantized free fields at a point. (auth)

**30810** THE PROBABILITY DENSITY FOR A SQUARE INTEGRABLE KLEIN–GORDON FIELD WITH INTERACTION. Henning, J. J. (Univ. of Pretoria). Z. Phys., 223: 116-25 (1969). (In German).

A four vector is constructed for the statistical interpretation of a relativistic scalar wave function which is not a solution of an interaction-free Klein–Gordon equation. The zero component of the four vector is positive definite, whereas the four components satisfy the equation of continuity. It is proved that these components, which are bilinear forms in $\Psi(x) = \int d^4p a(p) e^{-ipx}$ satisfying the normalization condition $(2\pi)^4(2m)^{-1}\int d^4p \theta(p^0)\theta(p^2)|a(p)|^2 = 1$ reduce to the four-vector of Petzold and co-workers if the transition from $\Psi(x)$ to the free-particle wave function $\Phi(x) = \int d^3p a(\vec{p}) e^{-ipx}$ satisfying $(2\pi)^3(2m)^{-1}\int (2\rho_0)^{-1}|a(\vec{p})|^2 d^3p = 1$ is made in the proper way. The nonrelativistic limit in the case of relativistic interactions is also discussed. (auth)

**30811** QUANTUM THEORY OF THE ANHARMONIC OSCILLATOR IN FUNCTIONAL SPACE. Stumpf, H. (Univ., Tuebingen, Ger.). Z. Naturforsch., 24a: 188-97(Feb. 1969).

Dynamics of quantum field theory can be formulated by functional equations. For strong interaction nonperturbative solutions of these functional equations are required. For the investigation of solution procedures the model of an anharmonic oscillator is used, because

of its structural equivalence with dressed one- and two-particle states of field theory. To perform a variational solution procedure a scalar product for the state functionals is introduced and its existence is proven. The scalar product definition admits a mapping of the physical Hilbert space on the functional space. Therefore a "functional" quantum theory seems to be possible. The whole procedure can be transferred to relativistic invariant field theories, provided these theories are regularized to give finite results at all. (auth)

**30812** ASYMPTOTIC CONDITION IN QUANTUM THEORY OF A FIELD WITH A PARAMETER. Karwowski, W.; Sznajder, N. (Univ. of Wroclaw). Acta Phys. Pol., 35: 813-28(May 1969).

Under usual axioms and some additional assumptions the asymptotic condition for a field A(x,s) with a parameter is proved. In addition to the results analogous to the one of Hepp in the Haag–Ruelle theory some new theorems are derived. The possibility of replacing the non-overlapping states by usual scattering states is discussed. (auth)

**30813** BOUND-STATE SOLUTIONS OF THE BETHE–SALPETER EQUATION IN MOMENTUM SPACE. zur Linden, E.; Mitter, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim., 61B: 389-402(June 11, 1969).

The Bethe–Salpeter equation is investigated in the ladder approximation for a Yukawa-type coupling of three scalar fields of different masses. By means of an expansion in terms of Gegenbauer polynomials in (Euclidean) momentum space a system of one-dimensional integral equations is obtained, which turns out to be very appropriate for numerical solution. The lowest eigenvalues for bound states of angular momentum zero are given for various mass ratios of the particles involved. The convergence of the numerical approximations is examined. The method can be applied also in the case in which a superposition of particles with different masses is exchanged. As an example the inclusion of self-energy effects in the propagator of the exchanged particle is considered for the case of equal external masses. (auth)

**30814** FIELD THEORETIC PROPERTIES OF NELSON'S MODEL. Cannon, John Tucker. Princeton, N. J., Princeton Univ., 1968. 168p.

Thesis.

Quantum field theoretic properties associated with Nelson's Hamiltonian for the Yukawa-like coupling of nonrelativistic, spinless "nucleons" with a relativistic scalar "meson" field are studied. Let $H_\kappa$ denote Nelson's Hamiltonian in the case that a cut-off is introduced on the high momentum contributions to the perturbing part. The domain intersection $\bigcap_{n=1}^{\infty} D(H_\kappa^n)$ is characterized; whence, by a method due to Jaffe the Heisenberg picture fields, the vacuum expectation values, the Green's functions, and their current equations are rigorously obtained. The characterization fails when the cut-off is removed; so a new method is developed. Let H denote Nelson's Hamiltonian for the case without cut-off and let $B_{n_0}^1$ be the operator given by $(B_{n_0}^1 \Psi)^n = \begin{cases} n^{1/2} \Psi^n & \text{if } n \geq n_0 \\ n_0^{1/2} \Psi^n & \text{if } n \leq n_0 \end{cases}$ where $\Psi^n$ is the n-meson component of a vector $\Psi$. It is shown by a generalization of Nelson's method that an appropiate restriction of $\hat{H}$ is an "approximately self-adjoint" infinitesimal generator on $D(n^{1/2})$ in $\|B_{n_0}^1 \cdot\|$ norm for $n_0$ large. Thus, on $D(n^{1/2})$ in $\|B_{n_0}^1 \cdot\|$ norm, $e^{i\hat{H}t}$ is contracting and holomorphic for t in an arbitrarily wide sector of the upper half-plane for $n_0$ large enough. This is adequate for the construction of polynomially bounded holomorphic vacuum expectation values for complex-time in an octant tube. The desired real-time vacuum expectation values are obtained in the sense of tempered distributions as boundary values. Basic properties of these boundary values are studied; in particular, they are limits in the sense of tempered distributions of the renormalized cut-off vacuum expectation values. However, Green's functions are not obtained. In the case that the coupling constant is small the "one-body problem" for "physical nucleons" is solved. For this the Hamiltonian is reduced as a direct integral over the total momentum; Nelson's method is applied to the reduced Hamiltonian and the eigenvalue problem is solved by the usual resolvent expansion except that convergence is obtained for the topology dual to that of $D(H_0^\infty)$ in the state space inner product. (Disser. Abstr.)

## *Gravitation and General Relativity*

*Refer also to abstract 30395.*

**30815** ON THE MATHEMATICAL STRUCTURE OF EINSTEIN'S EQUATIONS IN MIXED INITIAL AND BOUNDARY VALUE PROBLEMS. Massa, Enrico (Univ., Genoa). Commun. Math. Phys., 12: 246-52(1969).

It is shown that, also in the mixed initial and boundary value problem, Einstein's equations may be replaced by the two subsystems $T_1^m{}_{/\!/m} = 0$ and $R_{\alpha\beta} = -\varkappa(T_{\alpha\beta} - (1/2)\, T g_{\alpha\beta})$, provided that the initial data verify the consistency conditions $G_1^4 = -\varkappa T_1^4$ and that the analogous relations $(G_{1m} + \varkappa T_{1m})\, N^m = 0$ are imposed on the boundaries of the given domain. (auth)

**30816** GRAVITATIONAL RECOIL. Unt, V. (Inst. of Physics and Astronomy, Tallinn). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 18: No. 1, 103-5(1969). (In Russian).

Certain terms in the Einstein equations are integrated and analyzed as magnitudes describing the source recoil due to the gravitational emission. (tr-auth)

**30817** SCALAR HYDRODYNAMICS AND GRAVITATION. O'Hanlon, John; Tam, Kwok-kee (Univ. of British Columbia, Vancouver). Can. J. Phys., 47: 853-8(Apr. 15, 1969).

The relativistic hydrodynamical equations governing the behavior of a system of classical particles interacting through a scalar field in the presence of gravitation are presented. The motion of a scalarly charged particle in external scalar and gravitational fields is investigated. The linear dispersion relation for a zero-temperature, classical scalar plasma in the presence of an external gravitational field is also derived. Some consequences are discussed. (auth)

**30818** SPACE, TIME, AND ELEMENTARY INTERACTIONS IN RELATIVITY. Sachs, Mendel (State Univ. of New York, Buffalo). Phys. Today, 22: No. 2, 51-60(Feb. 1969).

A review is given of relativity theory. The principle of relativity, elementarity of interaction, the unified field concept, universal interaction, and a generalized Mach principle are covered. (J.F.P.)

**30819** NONSATURATION OF GRAVITATIONAL FORCES. Levy-Leblond, Jean-Marc (Physique Theorique, Nice). J. Math. Phys. (N. Y.), 10: 806-12(May 1969).

Rigorous inequalities are derived for the ground-state energy of a nonrelativistic quantum-mechanical system of N particles in gravitational interaction. It is shown that gravitational forces do not saturate, the binding energy per particle increasing with N, like $N^2$ for a Bose system, like $(N^{5/3})$ for a Fermi system. As a by-product, a generally valid Heisenberg-like inequality is obtained for N-fermion systems, expressing very simply the effect of the Pauli exclusion principle. These results are extended to the case of a system of oppositely charged particles which is shown to behave, with respect to gravitational forces, as a Fermi system as soon as particles with one sign of charge only are identical fermions. This explains quantitatively how and when gravitational forces finally predominate over Coulomb forces for large enough bodies (planets). A further extension to the case where relativistic effects enter only at the kinematical level permits one to derive rigorously from first principles the existence and an estimate of the Chandrasekhar mass limit, above which no collection of cold matter is stable (white dwarf stars). (auth)

**30820** STATIONARY "NONCANONICAL" SOLUTIONS OF THE EINSTEIN VACUUM FIELD EQUATIONS. Hoffman, Richard B. (Temple Univ., Philadelphia). J. Math. Phys. (N. Y.), 10: 953-6(May 1969).

The complete set of nonflat normal-hyperbolic solutions of the Einstein vacuum field equations is obtained for the metric tensor defined by the quadratic differential form $ds^2 = \alpha\, du^2 - 2\gamma\, du\, dv - \beta\, dv^2 - e^\varphi(dx^2 + dz^2)$ subject to the condition that $\alpha\beta + \gamma^2$ is constant. These solutions are characterized by the existence of a null hypersurface-orthogonal Killing vector, which is also a four-fold degenerate Debever vector with vanishing covariant derivative, and therefore are a special case of the class of plane-fronted gravitational waves. (auth)

**30821** COVARIANT FORMULATION OF THE CAUCHY PROBLEM IN GENERALIZED ELECTRODYNAMICS AND GENERAL RELATIVITY. Stachel, J. (Boston Univ.). Acta Phys. Pol., 35: 689-709(May 1969).

The Cauchy problem in a manifold is formulated geometrically as the problem of the continuation of certain field variables off a rigged hypersurface of the manifold, given certain initial data on that hypersurface, and a system of covariant partial differential equations obeyed by the field variables. The Lie derivative is shown to lend itself naturally to such a formulation. The Cauchy problem for generalized electrodynamics and spacelike initial hypersurfaces in general relativity is formulated and discussed from this point of view. It is shown that without the constitutive equations the propagation characteristics of Maxwell's equations

are undefined. A Newtonian form for the field equations of general relativity is given, and a Hamiltonian form using Lie derivatives is developed from the Lagrangian for the field equations. All calculations are explicitly covariant, and the geometrical interpretation of the results thereby becomes obvious. (auth)

**30822** HOMOGENEOUS EINSTEIN SPACES. Jensen, Gary Richard. Berkeley, Calif., Univ. of California, 1968. 67p. Thesis.

Let M be a Riemannian manifold with metric tensor g and with Ricci tensor S. M is called an Einstein space if $S = \lambda g$, where $\lambda$ is a scalar function on M necessarily constant if M is connected and dim $M \geq 3$. M is homogeneous if it has a group of isometries acting transitively on it. All four-dimensional, simply connected, homogeneous Einstein spaces are found. They are listed in the following table. All of these spaces are Riemannian symmetric spaces.

| $\lambda$ | M |
|---|---|
| $\lambda > 0$ | C(+,4), P(2,C), C(+2,) × C(+,2) (equal curvature on each factor) |
| $\lambda = 0$ | C(0,4) |
| $\lambda < 0$ | C(−,4), H(2,C), C(−,2) × C(−,2) (equal curvature on each factor) |

where C[(+/0),n] = space of constant (+/0) curvature of n dimensions,
P(2,C) = complex projective space of two complex dimensions,
H(2,C) = hermitian hyperbolic space of two complex dimensions.

The last four spaces listed in the table are realizable as group manifolds, that is, a manifold with a group of isometries acting simply transitively on it. In the course of this investigation some general properties of Lie groups with left-invariant metrics were derived. In particular, a formula was found for the sectional curvature in terms of the inner product and Lie bracket on the Lie algebra. This formula was used to prove certain relations between the group and the Ricci tensor. For example, a nonabelian nilpotent group cannot be an Einstein space; and, a four-dimensional group manifold which is an Einstein space must be solvable, but nonnilpotent. If M has a large enough group of isometries, a method of E. Cartan's can be employed to successfully determine when M is an Einstein space. When the group of isometries acts simply transitively on M, it becomes necessary to make a direct, detailed investigation of the equation $S = \lambda g$ on a solvable group manifold. (Disser. Abstr.)

**30823** COVARIANT TETRAD CONSERVATION-LAW GENERATORS. Davis, W. R.; York, J. W. Jr. (North Carolina State Univ., Raleigh). Nuovo Cim., 61B: 271-6(June 11, 1969).

A tetrad formulation of the conservation-law generator of general relativity is presented. This expression has the expected tensor character and appropriately reduces to Møller's tetrad superpotential. Use of this expression in the explicit formulation of the actual conservation laws admitted requires considerations of the symmetry properties, if any, of the given space-time. The intrinsic form of the conservation-law generator, which is fundamental to local applications of the conservation laws, is given. Also, several alternative tetrad formulations of "conservation-law generators" are briefly considered. (auth)

**30824** EXACT SOLUTIONS OF THE EINSTEIN VACUUM FIELD EQUATIONS IN WEYL CO-ORDINATES. Gautreau, R. (Newark Coll. of Engineering, N. J.); Hoffman, R. B. Nuovo Cim., 61B: 411-24(June 11, 1969).

Inconsistencies inherent in the interpretation of the canonical Weyl co-ordinates in the quadratic differential form for static, axially symmetric distributions of matter in general relativity as the time t and the cylindrical co-ordinates r, z, $\varphi$ are demonstrated in a number of ways. The most general Weyl quadratic differential form in which the metric is a function of only the radial co-ordinate is analyzed. This solution depends upon a single parameter $\sigma$, and reasons are given for interpreting this solution as an infinite line of positive mass for $0 < \sigma < \frac{1}{2}$; a homogeneous gravitational field for $\sigma = +1$, and in infinite sheet of negative mass for $\sigma = -1$. All solutions are given which correspond to flat space, and these are used to demonstrate that if one has two Weyl potentials each corresponding to a physical system, the sum of the two potentials is not the potential corresponding to the superposition of the two physical systems. (auth)

**30825** SCHROEDINGER, KLEIN-GORDON, AND DIRAC EQUATIONS AS TRANSPORT EQUATIONS IN MINKOWSKI SPACE. Bergstroem, A. (Research Inst. of National Defense, Stockholm). Nuovo Cim., 61B: 225-33(June 11, 1969).

The formulation by Feynman of the Schrödinger and Dirac equations as describing successive scatterings of wave functions against a potential is restated in terms of linear transport theory in Minkowski space $x_1x_2x_3x_4(=ict)$. The Schrödinger and Klein-Gordon equations will then be analogous to diffusion approximations of the Boltzmann equation, which is the rigorous equation for linear transport problems. Another approximation of the Boltzmann equation involving a somewhat more detailed description of the angular dependence of the flux than diffusion theory is developed and shown to be an analog to the Dirac equation. (auth)

## Scattering Theory

*Refer also to abstracts 30684, 30721, 30743, 30744, and 31060.*

**30826** (NP-17884) RIGOROUS DERIVATION OF PROJECTION FORMULAS FOR 0(2,1)-INVARIANT OFF-SHELL FUNCTIONS. Note No. 201. Ferrara, S.; Mattioli, G. (Rome Univ. (Italy). Istituto di Fisica). Jan. 8, 1969. 14p. Dep.

Projection formulas, which allow one to perform the generalized Laplace transform for a class of 0(2,1)-invariant off-shell functions, are derived in a rigorous way. The usefulness of this transformation is shown for the physical case of spinless particles scattering described by iterated ladder graphs. (auth)

**30827** SCATTERING INTO CONES. I. POTENTIAL SCATTERING. Dollard, John Day (Univ. of Rochester, N. Y.). Commun. Math. Phys., 12: 193-203(1969).

In the nonrelativistic time-dependent theory of scattering, the probability that a particle with given initial state should scatter into a cone with apex at the origin is computed. A formula for this probability is found which holds good for a large class of short-range potentials and also for Coulomb potentials. The formula is obtained by showing that if the initial state of a particle is specified by f, then its position probability density at large positive times can be taken to be $|(e^{-\frac{1}{2}iHt}e^{iH_0t}f)(x)|^2$. (auth)

**30828** CORRECT ASYMPTOTIC $\lambda$ BEHAVIOR OF THE PARTIAL-WAVE AMPLITUDE. Spector, R. M. (Wayne State Univ., Detroit). Nuovo Cim., 61A: 67-72(May 1, 1969).

The asymptotic $\lambda$ behavior of the analytically continued partial-wave amplitude is commonly given (incorrectly) as $O(\lambda^{-\frac{1}{2}}\exp[-\Gamma\lambda])$. This result is exercised by a careful study of the past Regge literature. The original (correct) result of $O(\lambda^{-\frac{1}{2}}\exp[-\Gamma\lambda])$ is resurrected, and the conditions under which it is valid, as well as its implications, are carefully discussed. (auth)

**30829** LARGE-MOMENTUM-TRANSFER DIFFRACTION SCATTERING AND PRODUCTION. Frautschi, S.; Kofoed-Hansen, O.; Margolis, B. (CERN, Geneva). Nuovo Cim., 61A: 41-55(May 1, 1969).

Previously, multiple-scattering corrections to a Regge-pole exchange model were generated. It is shown in detail how the multiple-scattering series, which is a sum of Gaussians in momentum transfer, adds up approximately to an exponential in momentum transfer. Special care is required in this evaluation on account of the oscillating nature of the terms in the series. Since the amplitudes at large $|t|$ are dominated by multiple scattering in this model, the large-$|t|$ behavior of the single-scattering amplitude is obscured. Polarization phenomena in the same model are discussed briefly. (auth)

**30830** REGGE REPRESENTATION FOR FORWARD SCATTERING OF UNEQUAL-MASS PARTICLES. Drechsler, W. (CERN, Geneva). Nuovo Cim., 61A: 1-19(May 1, 1969).

The Sommerfeld-Watson transformation of a t-channel helicity amplitude is investigated for $z_t = \pm 1$ corresponding to forward scattering of unequal-mass particles in the s-channel. It is shown that the Sommerfeld-Watson transform exists at these points under similar conditions as in the case of large $|z_t|$ and that it corresponds to a finite Regge-pole contribution. This eliminates the infinities of the conventional Regge representation at $z_t = \pm 1$. A modified Regge representation for helicity amplitudes is given, which guarantees a continuous behavior of the scattering amplitude for unequal-mass particles near the forward direction. (auth)

**30831** GENERALIZED PARTIAL-WAVE ANALYSIS AND KINEMATIC SINGULARITIES. Toller, M. (CERN, Geneva). pp 15-31 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

The procedure of the generalized partial wave analysis is illustrated, and it is shown that when this procedure is used in connection with the analytic properties of the amplitude it is useful for the description of relativistic scattering and production processes. Regge pole kinematics are discussed. (J.F.P.)

**30832** LITTLE GROUPS, ANALYTICITY, AND FAMILIES OF REGGE TRAJECTORIES. Domokos, G. (Central Research Inst. for Physics, Budapest). pp 33-58 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

A review of some ideas in the development of Regge pole theory is given. The group properties of composite states are studied, and it is shown how problems in Regge pole theory can be traced to the composite particle spin algebra. (J.F.P.)

**30833** ON THE ZERO ENERGY BEHAVIOUR OF REGGE POLES AND RESIDUES. Salam, Abdus; Strathdee, J. (Imperial Coll. of Science and Tech., London. International Centre for Theoretical Physics, Trieste, Italy). pp 59-103 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

The behavior of partial-wave amplitudes in the neighborhood of vanishing momentum is studied in the Born approximation. A set of phenomenological fields is introduced to assist in the construction of a kinematically correct Born term. It is found that the Born contribution to the partial-wave amplitudes has a structure which, as a result of the kinematical properties of the phenomenological and vertex parts, yields considerable information about the behavior of Regge poles and residues at zero energy. Regge poles arrived at in this way group themselves into Toller families whose zero energy intercepts, slopes, etc. are severely constrained. Asymptotic formulas for forward scattering amplitudes are obtained. (auth)

**30834** A THEORY OF THREE-PARTICLE FORM FACTORS WITH APPLICATION TO THE DEFINITION OF CURRENTS IN S-MATRIX THEORIES. Omnes, R. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). pp 319-30 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

The formulation of the three-body problem within the framework of S-matrix theory is considered. It is concluded that the electromagnetic form factors for a three-pion state exist, up to the mentioned provisions. (J.F.P.)

**30835** DERIVATION OF THE COULOMB AMPLITUDE FROM S-MATRIX ASSUMPTIONS. Omnes, R. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). pp 331-4 of Elementary Particle Theory. Svartholm, Nils (ed.). New York, John Wiley and Sons, Inc., 1968.

From 8th Nobel Symposium on Elementary Particle Theory, Goteborg, Sweden. See CONF-680519.

The assumptions that must be put into an S-matrix theory to make it a dynamical theory are found. It is shown that very strong asymptotic conditions are necessary even for an extremely simple problem. (J.F.P.)

**30836** FIXED AND REGGE POLES IN THE VENEZIANO MODEL. Alessandrini, V. (International Centre for Theoretical Physics, Trieste, Italy); Amati, D. Phys. Lett., 29B: 193-7(Apr. 28, 1969).

It is shown that the narrow resonance Veneziano model has—besides the equally spaced Regge poles—fixed poles at nonsense integer (negative integer for spinless scattering particles) wrong signature angular momentum. (auth)

**30837** DETERMINATION OF INVARIANT AMPLITUDES FROM EXPERIMENTAL OBSERVABLES. Moravcsik, Michael J.; Yu, Wing-Yin (Univ. of Oregon, Eugene). J. Math. Phys. (N. Y.), 10: 925-8(May 1969).

Necessary and sufficient conditions are formulated for deciding whether a set of 2n−1 bilinear products of n complex amplitudes determines these amplitudes with no continuum of ambiguity or not. The conditions can be translated into very simple geometrical prescriptions which in most cases provide quick and easy practical tests for such decisions. (auth)

**30838** BEST ERROR BOUNDS FOR PADE APPROXIMANTS TO CONVERGENT SERIES OF STIELTJES. Baker, George A. Jr. (Brookhaven National Lab., Upton, N. Y.). J. Math. Phys. (N. Y.), 10: 814-20(May 1969).

A series of Stieltjes with a nonzero radius of convergence R is considered. By way of Padé approximants the allowed range of values is established for such functions at any point in the cut $(-\infty < z \leq -R)$ complex plane when a finite number of Taylor-series coefficients are known. The previous results for z real and positive are sharpened. The fitting problem is investigated and again error bounds are given throughout the cut complex plane, and necessary and sufficient conditions are given that the set of values fitted be values of a series of Stieltjes with radius of convergence at least R. (auth)

**30839** MACROSCOPIC CAUSALITY CONDITIONS AND PROPERTIES OF SCATTERING AMPLITUDES. Chandler, Colston; Stapp, Henry P. (Univ. of California, Berkeley). J. Math. Phys. (N. Y.), 10: 826-59(May 1969).

Two causality conditions that refer only to mass-shell quantities are formulated and their consequences explored. The first condition, called weak asymptotic causality, expresses the requirement that some interaction between the initial particles must occur before the last interaction from which final particles emerge. This condition is shown to imply that if a two-body scattering function is analytic except for singularities in the energy variable at normal thresholds, then (a) the physical scattering functions in two adjacent parts of the physical region separated by any normal threshold are parts of a single analytic function; (b) the path of continuation joining these two parts bypasses the singularity in the upper half-plane of the energy variable; and (c) the integral over the physical function can be represented as an integral over a contour that is distorted into the upper-half energy plane (hence not, for example, by a principal-value integral). Singularities possessing finite derivatives of all orders with respect to real variations of the energy are not encompassed by this result. The second causality condition, called strong asymptotic causality, expresses the requirement that, apart from contributions whose effects fall off faster than any inverse power of Euclidean distance, momentum-energy is carried over macroscopic distances only by stable physical particles. This condition implies that all n-particle scattering functions ($n \geq 4$) are analytic, apart from infinitely differentiable singularities, at physical points not lying on any positive-$\alpha$ Landau surface. Moreover, the scattering functions on the two sides of any such Landau surface are analytically connected by a path that passes around the singularity surface in a well defined manner, which is the same as in perturbation theory. Thus, apart from possible infinitely differentiable singularities, the physical region singularity structure is derived from a mass-shell causality requirement. Several properties of the set $\mathfrak{L}^+$ of physical region positive-$\alpha$ Landau surfaces are derived. (auth)

**30840** OREAR BEHAVIOR IN POTENTIAL SCATTERING. II. Johnson, Porter W. (Case Western Reserve Univ., Cleveland). J. Math. Phys. (N. Y.), 10: 946-53(May 1969).

Certain results obtained previously concerning high-energy large-angle scattering upon nonsingular potentials V(r) which are even in r and analytic in a finite strip about the real r axis are extended. (Previously, it was required that the potentials have a larger domain of analyticity than is required here.) The scattering amplitude is compared with the first Born approximation for this wider class of potentials. (auth)

**30841** ON THE QUANTUM-MECHANICAL N-BODY PROBLEM. Hepp, Klaus (Eidgenoessische Technische Hochschule, Zurich). Helv. Phys. Acta, 42: 425-58(May 16, 1969).

Systems of a finite number of nonrelativistic particles are studied in the framework of time-independent quantum scattering theory in the approach of Faddeev. For a nonempty class of 2-body potentials, the unitarity of the S matrix and a singularity structure of resolvent kernels and scattering amplitudes in the physical region is proven which is qualitatively the same as in perturbation theory. (auth)

**30842** S-MATRIX UNITARITY PROBLEM. Garczynski, W. (Univ. of Wroclaw). Acta Phys. Pol., 35: 759-63(May 1969).

The S-matrix unitary problem is discussed in the axiomatic framework of quantum field theory. The necessary and sufficient condition, in terms of the aperture of the asymptotic subspaces, for unitarity of the S-matrix is proposed. (auth)

**30843** BRANCH POINTS IN THE COMPLEX ANGULAR-MOMENTUM PLANE. Mickens, Ronald Elbert. Nashville, Vanderbilt Univ., 1968. 67p.

Thesis.

Various theoretical methods for studying analytic properties of collision amplitudes at high energies are considered. A summary of Regge theory is given. Reasons are given for the necessary existence of moving branch points in the complex angular-momentum plane. New results are listed. (Disser. Abstr.)

**30844** ANGULAR-MOMENTUM REDUCTION OF THE FADDEEV EQUATIONS. Balian, R.; Brezin, E. (Centre d'Etudes Nucleaires, Saclay, France). Nuovo Cim., 61B: 403-10(June 11, 1969).

Angular-momentum reduction of the Faddeev equations is reexamined. The symmetrical and unsymmetrical coupling schemes are directly related. A simpler explicit form is proposed, from which it appears that the number of coupled amplitudes has been overestimated. A sign oversight, relevant for calculating states with nonzero orbital momentum, is pointed out in some previous treatments. (auth)

## Particle Accelerators

*Refer also to abstracts 28772, 29281, 30689, 30706, 30920, and 30934.*

**30845** (AD-683657) REPORT ON LINAC OPERATION, Interim Report No. 7, July 1-December 31, 1968. Godlove, T. F. (Naval Research Lab., Washington, D. C.). Jan. 1969. 27p. (NRL-MR-1960). CFSTI.

The operation and use of the NRL 60 MeV Electron Linear Accelerator is described for the period 1 July-31 December 1968. Progress on the Linac Branch research program is discussed, including results of electron scattering on s-d shell nuclei, progress on two $^{16}O$ photonuclear experiments, and studies of thermal neutron capture on Yb isotopes. The time-of-flight facility, used for resonance neutron capture experiments, is operational and preliminary results on capture by $^{170}Yb$ have been obtained. A newly-installed gas target chamber for the electron scattering facility has enabled new data on $^{20}Ne$ to be taken. Total beam time (including set-up time) increased from 1058 hours (1 January-30 June 1968) to 1672 hours, of which 303 hours were devoted to outside users. Time lost due to breakdowns decreased to 11.8% of the total time, which was 2370 hours. Klystron life continues to be excellent—only two have failed since the linac was built. (auth) (USGRDR)

**30846** (AD-683716) LARGE AREA PROTON BEAMS FOR RADIOBIOLOGIC RESEARCH FROM THE NASA-SREL SYNCHROCYCLOTRON, I. INVESTIGATION OF THE NOMINAL 300-MeV PRIMARY BEAM, II. INVESTIGATION OF THE NOMINAL 600-MeV PRIMARY BEAM, Final Report, July-December 1967. Blake, Kenneth R.; Boles, Larry A.; Nelson, John B.; Parker, C. Varren; Harris, Charles A. (Texas Nuclear Corp., Austin). Dec. 1968. Contract F41609-67-C-0106. 36p. (SAM-TR-68-79). CFSTI.

Measurements were made of the characteristics of large area proton beams for radiobiologic research from the 600-MeV synchrocyclotron. Proton beams with energies ranging from 450 to 150 MeV were produced by degrading the nominal 600-MeV primary beam to the desired energy with the appropriate thickness of aluminum, copper, or lead at the beam transport system exit port. Proton beams with energies ranging from 295 to 30 MeV were produced by degrading the nominal 300-MeV beam from the synchrocyclotron. In addition, the primary beams were expanded with the quadrupole magnets of the beam transport system, and the characteristics of these beams were investigated. The maximum proton flux and spatial distribution of the flux of the various beam configurations were measured at distances of 5, 10, and 15 feet from the exit port, and the corresponding dose rates in tissue were calculated from the maximum flux values. The intensity profiles of the degraded beams were found to be approximately Gaussian, and measurements of several such profiles indicated that the beams were approximately circular. The profile widths and dose rates were measured for many different configurations. (auth) (USGRDR)

**30847** (BMwF-FBK-69-10) A BEAM POSITION MONITOR FOR A PULSED ELECTRON BEAM. Brueckner, H. (Max-Planck-Institut fuer Chemie, Mainz (West Germany)). Apr. 1969. 28p. (In German). Dep.

A device is described which measures the position of a pulsed electron beam emerging from a linear accelerator. The essential parts are two coils wound on a ferrite core and an electronic circuit which handles the difference signal from the two coils in order to obtain a signal which is merely dependent on the beam position. The device has been used in routine measurements with pulse durations up to 2 μs. (auth)

**30848** (CERN-69-2) CONTRIBUTIONS TO THE THEORY OF THE SYMMETRIC QUADRUPOLE TRIPLET. Regenstreif, E. (Rennes Univ. (France). Faculte des Sciences. European Organization for Nuclear Research, Geneva (Switzerland)). Feb. 24, 1969. 138p. Dep.

The matrix elements of the triplet are written in a form suitable for analytic investigations. Their variation is then considered in terms of the inter-lens drift length. Particular attention is given to the cases of degeneracy of the matrix elements, these cases being of considerable importance in the study of the optical properties and in problems implying angular, radial and phase-space acceptances. All the important first-order optical characteristics of the triplet are derived starting from the matrix elements given previously. A more detailed discussion of the optical properties reveals the conditions under which one can obtain real images in both planes. The conditions leading to unit magnification and stigmatism are also investigated and the impossibility of obtaining intrinsic stigmatism is pointed out. As a transition from the concept of a purely optical device, and that of a beam transport element, angular and radial acceptances are considered and formulas for these characteristics are derived. Also, the paramount characteristic of the triplet in connection with its beam transport properties, i.e., its phase acceptance, is examined and explicit formulas are established giving the phase acceptance either in terms of the matrix elements or directly in terms of the physical parameters of the triplet. The analytic form of the phase acceptance allows then a closer investigation and this study reveals a fundamental discrepancy between the two planes of the triplet: contrary to the focusing-defocusing-focusing plane where the phase acceptance steadily decreases when the inter-lens drift length goes from zero to infinity, conditions leading to a maximum of the phase-space acceptance in the defocusing-focusing-defocusing plane can be found. Also, in the latter plane, the derivative of the phase acceptance versus drift length shows a true discontinuity, which can be regarded as a separatrix of operational conditions. (auth)

**30849** (CERN-Trans-69-4) MAGNETIC CHARACTERISTICS OF THE UNITS OF THE RING MAGNET OF THE 70-GeV PROTON SYNCHROTRON. Mozalevskii, I. A.; Veselov, M. D. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). Translated into French by A. Golovanoff (CERN, Geneva, Switzerland), from a Russian report. 26p. (In French). Dep.

Results are presented from magnetic measurements of ring electromagnet units for the IHEP accelerator. These results cover the period from April to August, 1967. Tables are given for the results of magnetic calibration of the electromagnetic units and for the principle magnetic characteristic types of units. (J.F.P.)

**30850** (CERN-Trans-69-6) PARTICLE INJECTION SYSTEM OF THE 70 GeV PROTON SYNCHROTRON OF IFVE. Boiko, S. N.; Zaitsev, V. I.; Mayae, E. A.; Roife, I. M.; Stekol'nikov, B. A. (Bosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated into French by A. Golovanoff (CERN, Geneva), from report IFVE-SKU-68-48-K. 38p. (In French). Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 19081. (W.H.K.)

**30851** (CERN-Trans-69-8) FOCUSING OF RINGS OF CHARGED ELECTRONS IN THE COLLECTIVE LINEAR ACCELERATOR. Bonch-Osmolovskii, A. G.; Dolbilov, G. V.; Ivanov, I. N.; Perel'shtein, E. A.; Sarantsev, V. P.; Yarkovoi, O. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). Translated by A. Golovanoff (CERN, Geneva, Switzerland), from report JINR-P9-4135. 11p. (In French). Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 7202. (W.H.K.)

**30852** (DNPL/P-6) OPERATIONAL HEALTH PHYSICS AT THE 5-GeV ELECTRON SYNCHROTRON NINA. Coleman, F. J. (Daresbury Nuclear Physics Lab. (England)). Apr. 1969. 34p. (CONF-690320-1). Dep.

From Conference on Radiation Protection in Accelerator Environments, Chilton, England.

Health physics precautions associated with the high energy accelerator N.I.N.A. (National Institute Northern Accelerator) are discussed. The fixed monitor system which continuously monitors the stray radiation around the site is described, together with the special instrumentation and methods necessary to measure the mixed high energy radiation field near the experimental areas. A description of the personnel safety system and the classification of radiation controlled areas is included. The "machine OFF" conditions include measurements of the induced

activity in the vacuum system and assessment of the possible hazards of noxious gases and active air to personnel entering the machine just after switch-off. Also presented are some typical "machine ON" radiation conditions. (auth) (UK)

**30853** (IFA-CRD-37) FAST ELECTRONICS FOR FAST NEUTRON SPECTROMETRY FOR THE CYCLOTRON. Molea, M. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1968. 23p. (In French). Dep.

Experiments are described which allow one to measure the angular distributions of spectra of the emerging particles (protons, alpha particles, or neutrons) and of the correlations $p\gamma$, $\alpha p$, and $n\gamma$ for the polarization of protons, alpha particles, and neutrons. For fast neutrons, time-of-flight spectrometers with coincidence circuits were constructed. (J.F.P.)

**30854** (LA-4118) MEDIUM-ENERGY PHYSICS PROGRAM. Quarterly Status Report for the Period Ending January 31, 1969. (Los Alamos Scientific Lab., N. Mex.). Mar. 6, 1969. Contract W-7405-eng-36. 48p. Dep. CFSTI.

The medium-energy physics program at LASL is described. Topics discussed include accelerator structures, rf power systems, accelerator control and instrumentation, accelerator physics, the experimental area, LAMPF scheduling and facility construction, and the pion production experiment. (J.F.P.)

**30855** (MPS/Int.CO-68-13) THE CPS IONIZATION BEAM SCANNER (IBS). Johnson, C. D.; Thorndahl, L. (European Organization for Nuclear Research, Geneva (Switzerland)). July 9, 1968. 21p. Dep.

Following some early model studies, a non-destructive residual-gas ionization proton beam scanner for the CPS ring was constructed and installed in s.s. 12 at Easter 1968. Deriving a signal from the electrons liberated by the proton beam from the residual gas of the vacuum chamber, and using a crossed electric and magnetic fields system of electron collection, the scanner gives proton density distributions in the horizontal plane with a spatial resolution of better than 1 mm. The ultimate time resolution will be better than 10 $\mu$s. Six weeks of trials during normal CPS operation and also during some machine development periods yielded many interesting results. A full description of the principles of the device, its construction, performance, and some proposals for its future use are presented. (auth)

**30856** (NP-17900) DARESBURY NUCLEAR PHYSICS LABORATORY. Annual Report, 1968. (Daresbury Nuclear Physics Lab. (England)). 72p. Dep.

Details are given of the organization of the Laboratory, and the work carried out in experimental physics. The information is presented under the following headings: Introduction; experimental physics; theoretical physics; physics apparatus and measurements; computer work; operation and future development of the electron synchrotron NINA; machine physics investigations; engineering; and administration. (UK)

**30857** (NP-tr-1781) GAS DISCHARGE ION SOURCE FOR AN ELECTROMAGNETIC SEPARATOR OPERATING ON-LINE WITH A HEAVY ION CYCLOTRON. Tarantin, N. I.; Dem'yanov, A. V.; Ivanov, N. S.; Kabachenko, A. P. ([Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions]). Translated by D. L. Allan (Atomic Energy Research Establishment, Harwell, Eng.), from report JINR-P13-4061. 28p. Dep. CFSTI.

The design and some operation characteristics of a gas discharge ion source for use with an electromagnetic mass separator operating on-line with a heavy ion cyclotron are presented. (W.H.K.)

**30858** (RHEL/R-175) NIMROD OPERATION AND DEVELOPMENT. Quarterly Report, July 1-September 30, 1968. Gray, D. E. (ed.) (Rutherford High Energy Lab., Chilton (England)). Dec. 1968. 28p. Dep. CFSTI. UK 4s. 6d.

Work reported includes the following: Details of operation of the NIMROD accelerator; measurement of effective spill time for slow spill targeting; measurement of RF structure on slow spill; and radiation dosimetry (inner vacuum vessel, plunging magnet, outer vacuum vessel, pressure bag, and extracted proton beam lines). The experimental program is also summarized. (UK)

**30859** (RHEL/R-178) NIMROD OPERATION AND DEVELOPMENT. Quarterly Report, October 1-December 31, 1968. Gray, D. E. (ed.) (Rutherford High Energy Lab., Chilton (England)). Feb. 1969. 22p. Dep. CFSTI. UK 4s. 0d.

Work reported includes the following: operation of the NIMROD accelerator; development of switched extraction magnet power supply; current stabilization; radiation protection (radiation measurements around extracted proton beams, biological dosimetry, contamination resulting from failure of uranium target); radiation dosimetry (inner vacuum vessel). The experimental programme is also summarized. (UK)

**30860** (SLAC-100) DIGITAL COMPUTER ERROR ANALYSIS OF A RESONANT TOROID CHARGE MONITOR. Horelick, Dale; Larsen, Raymond S. (Stanford Linear Accelerator Center, Calif.). Mar. 1969. Contract AT(04-3)-515. 25p. Dep. CFSTI.

A mathematically exact error analysis is performed on an ideal resonant toroid charge monitor for varying beam pulse width, assuming calibration with a known impulse charge. An optimum waveform sampling point is derived from the data, which minimizes the error. The effects of using a rectangular calibration pulse are analyzed, and the error for an impulse beam is calculated as a limiting case of beam charge distribution. Errors for variation in system timing are also analyzed. All computations are performed on a digital computer to obtain the required precision. The results show that a maximum error of $\pm 0.012\%$ can be achieved over a pulse width range of 0-2 $\mu$sec, with a resonant frequency of 5.25 kHz and a damping time constant of 0.33 msec. Under the same conditions the maximum timing error is about $-0.07\%/\mu$sec. (auth)

**30861** CHARGED PARTICLE TRAJECTORY AND POTENTIAL DISTRIBUTION IN A FLAT DISK TYPE ACCELERATION TUBE AND EINZEL LENS. I. Takagi, Takashi; Mizuno, Kenichi (Mitsubishi Electric Corp., Amagasaki, Japan). Mitsubishi Denki Giho, 43: 596-601(Apr. 1969). (In Japanese).

Multi-stage acceleration tubes have been used in electrostatic generators, particularly in Van de Graaff accelerators. The numerical techniques used for calculating the potential distribution in order to determine the properties of lenses in the injection region of the accelerator tube are described. Results of calculations on the focusing action of an Einzel lens are presented. (B.G.D.)

**30862** ELECTRON LOADING OF 1 MV VAN DE GRAAFF TYPE POSITIVE-ION ACCELERATOR. Furuta, Junichiro; Hiraoka, Eiichi (Osaka Prefectural Radiation Center, Sakai, Japan). Oyo Butsuri, 38: 316-51(Apr. 1969). (In Japanese).

Experimental results on electron loading of the 1 MW Van de Graaff type positive-ion accelerator, which has not been in use for long time, are reported. The accelerating tube is 70 cm in length and is composed of 28 sections, each of which is made of a porcelain cylinder and a stainless steel electrode of the re-entrant type. The results are as follows: (1) In the case of no ion beam. The threshold of x-ray generation caused by electron loading disappears simply after a short time of aging. The x-ray intensity increases approximately as the ninth power of the accelerating voltage (E). (2) In the case of ion beam flowing. The x-ray intensity increases approximately as $E^3$ and increases in proportion to the amount of the beam current. It also increases with the gas pressure in the accelerating tube. (3) When the accelerator is operated at 0.9 MV, the half value layer of steel for generated x-rays is 12 mm. This corresponds to x-ray energy of 0.7 MeV. (4) The x-rays are generated at a point near the ion source. (auth) (NSA of Japan)

**30863** DRIFT-CYCLOTRON INSTABILITY WITH TRAPPED PARTICLES. Ohkawa, Tihiro (Gulf General Atomic Inc., San Diego, Calif.). Kakuyugo Kenkyu, 22: 369-73(Apr. 1969). (In Japanese).

The dispersion relation for the drift cyclotron instability is modified to include the effects of trapped particles. The modification improves the agreement between the theory and the experimental observation in the Gulf General Atomic octopole device. (auth) (NSA of Japan)

**30864** DEVICE OF CHARGED-PARTICLE SOURCE. Sogo, Hideshi (to Hitachi Ltd.). Japanese Patent 1969-2679. Feb. 4, 1969. Filed July 26, 1965.

The design of a charged-particle source, applicable to electron linear accelerators for x-ray radiography or x-ray therapy, has the following advantages: power supply to the high frequency oscillator and electron gun with a single power-source circuit; the need for one pulser in the circuit; easy control of the electron current by simple adjustment of the bias voltage; and the easy overall operation. The device consists of the following: a charged-particle source with an electrode to control the electron current; a high frequency oscillator to supply a high-frequency power for acceleration of the electron current; a pulse transformer with a plurality of the secondary windings to the high-potential side of which are connected the source, oscillator, and control electrode; and a pulser to supply a pulse voltage to the primary winding of the pulse transformer. The pulse voltage, induced in the secon-

dary winding to which the control electrode is connected, is made smaller than that induced in the secondary winding connected with the source. A variable d-c bias power source is connected to the secondary winding connected with the control electrode on the low-potential side. (NSA of Japan)

**30865** EXPERIMENTAL DETERMINATION OF TIME-DEPENDENT CORRELATION COMPONENT FOR THE ENVELOPE INTENSITY OF BETATRON BREMSSTRAHLUNG. Vorob'ev, V. A.; Tarasov, G. P. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 12, 139-42(1968). (In Russian).

Coupling autocorrelations obtained for bremsstrahlung enveloping intensity rate in a betatron with fluctuating electron beam parameters indicated a strong influence exerted by unstable energy of electrons in a target on the fluctuation of the rate of radiation. A method is developed for experimental determination of time-dependent enveloping intensity (in pulsating regime) which produces correlations with order of error not exceeding 10%. The time-dependent envelope intensity correlation for $\beta$-30 was $\tau_1 \approx$ 0.8 sec. (R.V.J.)

**30866** EFFECT OF THE SPACE CHARGE ON THE PARAMETRIC RESONANCE IN CYCLIC ACCELERATORS WITH SLOWLY CHANGING PARAMETERS. Polukhin, A. T. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., 24: 109-11(Jan.-Feb.(1969). (In Russian).

In view of the great importance of the behavior of betatron oscillations in the parametric resonance region, this phenomenon was examined, taking into account changes in the density, energy, and flux of the particles. A canonic equation which presents the $|\sigma|$ coefficient of the amplitude changes of betatron oscillations with respect to the original values, was used to consider the joint action of space charge and parametric perturbation. The energy-related change of $|\sigma|_{max}$ is determined by the relativistic factor $\gamma$ which assumes its lowest value upon injection. Therefore, the space charge and parametric perturbation exert their strongest effect immediately after injection. The results obtained are varied for space charges, for which the Coulomb repulsive forces are much smaller than the focusing forces of the external magnetic field. (TTT)

**30867** METHOD AND APPARATUS FOR BOMBARDMENT OF A TARGET BY A BEAM OF CHARGED PARTICLES. Moisand, Guy; Roche, Michel (to Commissariat a l'Energie Atomique). British Patent 1,151,825. May 14, 1969. Priority date Sept. 16, 1966, France.

A method for uniformly bombarding a circular area of a target by a forced beam of charged particles which comprises of subjecting the beam to the electric fields of two mutually perpendicularly disposed pairs of deflector plates to which are applied sinusoidal voltages mutually displaced in phase by $\pi/2$, the amplitude of each of the sinusoidal voltages being modulated so that each has a value defined by the equation $U = U_0(t) \sin 2\pi t/T$ where $U_0$ varies as a function of time in accordance with the relation $U_0(t) = \sqrt{at + b}$ and a and b are constants. (B.G.D.)

**30868** PARTICLE ACCELERATOR. Tawara, Hiroyuki (to Hitachi Ltd.). Japanese Patent 1969-2878. Feb. 3, 1969. Filed July 12, 1965.

In the particle accelerator proposed, the condition of focusing of particles to be accelerated can be adjusted easily and without breaking the vacuum. Within and at the end of an accelerating tube a cylindrical focusing electrode and a cylindrical particle-withdrawing electrode are installed in that order. Immediately outside the end, a plasma chamber is set which has an anode with a protruding cylinder on the side of an accelerating tube; this cylindrical body is in the focusing cylinder. The plasma chamber with the anode can be moved, air-tight, in the direction of the accelerating-tube axis, by means of the bellows in between. The focusing anode and the plasma chamber anode are maintained at the same potential. (NSA of Japan)

**30869** PARTICLE ACCELERATOR. Tawara, Hiroyuki (to Hitachi Ltd.). Japanese Patent 1969-2877. Feb. 3, 1969. Filed July 9, 1965.

By the method proposed, an accelerated particle beam of large intensity, i.e., a highly-focused beam can be obtained, for such uses as experiments in nuclear physics and as an injector for a powerful synchrotron. Usually, for this purpose a focusing magnetic-field is employed, but because of the large length of an accelerating tube and its high potential, it is impossible to supply the necessary power. In the particle accelerator proposed, this disadvantage is removed. The accelerator includes the following; a high voltage generator, an accelerating tube, the focusing coils attached onto the accelerating tube, and the power source for a particle source, made up by connecting in series insulating transformers. The power source for exciting the focusing coils is derived from the insulating transformers. (auth)

**30870** BETATRON. Tawara, Hiroyuki (to Hitachi Ltd.). Japanese Patent 1969-2879. Feb. 3, 1969. Filed Sept. 30, 1964.

In the betatron proposed, the x-ray output, upon bombardment of a target with accelerated electrons, can be increased without impairing the life of filaments of electron guns. To increase the x-ray intensity, the filament is operated, usually, at the expense of the filament life; then, the filaments must be exchanged frequently. By the method proposed, this disadvantage is removed; the x-ray intensity can be raised, as required. Along and onto the circular tube of the betatron, a plurality of, i.e., two, four, etc., electron guns are installed at the regular intervals, i.e., 180°, 90°, and so on. The electron injection from the respective electron guns is in the same circular direction. The x-ray output, compared with a single electron gun, is increased something like double, or the life, for the same output, of the electron guns is lengthened correspondingly. (NSA of Japan)

**30871** DEVICE FOR WITHDRAWING ACCELERATED ELECTRONS FROM A BETATRON. Tawara, Hiroyuki (to Hitachi Ltd.). Japanese Patent 1969-2880. Feb. 3, 1969. Filed Jan. 23, 1965.

In betatrons for medical use in particular, the usual arrangement is as follows: a peeler for drawing out the accelerated electrons, a means for adjusting the irradiation field with respect to the object, and then the object, i.e., the human body. In this case, however, the path of particles outside the accelerating tube is deflected by the leakage magnetism from the tube, the extent of this deflection depending on the energy of accelerated particles; then, the irradiation field adjuster must be altered, as required. This drawback can be removed by the proposed method. Between the peeler and the field adjuster, a shielding channel, against the external leakage magnetism, through which withdrawn particles pass, is installed. Alternatively, a coil in the form of a channel may be used, to which an electric current is applied so as to nullify the external magnetism. (NSA of Japan)

**30872** ELECTRON GUN FOR AN ELECTRON ACCELERATOR. Iwanami, Tomio (to Tokyo Shibaura Electric Co.). Japanese Patent 1969-4799. Feb. 21, 1969. Filed Aug. 30, 1965.

The electron gun proposed is used for particle accelerators such as a betatron. The electron gun in which secondary-electron emitting electrodes and a deflecting electrode are additionally employed, has the following advantages: small energy distribution of the obtained electrons, and easy shaping of the electron beam; easy placement of the electrons in a stable accelerating orbit; the multiplication of electrons due to the produced secondary electrons; and a long life of the electron source. The electron gun consists, in the order, of the following: an electron source, consisting of a grid electrode with a filament, and the anode; a series of the secondary-electron emitting electrodes in the shape of curved plates, forming an electron-path channel; a focusing electrode at the end of the series; and a deflecting electrode, located in front of the focusing electrode, for directing the obtained electrons to the acceleration. (NSA of Japan)

**30873** DEVICE FOR CONTROLLING A CHARGED-PARTICLE SOURCE IN THE ACCELERATOR. Aihara, Ryuzo (to Sumitomo Electric Industries, Ltd). Japanese Patent 1969-1400. Jan. 22, 1969. Filed Feb. 4, 1964.

The device proposed, which is used for controlling the emitter of charged particles, suspending the operation of the source in an emergency and adjusting the amount of charged particles, and has the following advantages: simple operation, no malfunctioning, no need for skills in the maintenance, and positive operation. Start or operation of the current for a particle source is done by cylinder switches, which are in turn controlled by three-way valves, operated with pressurized air or liquid. Then, in setting the current for the source at a specific value, an automatic adjuster device is used. The standard power source for the adjuster is operated by a plurality of cylinder switches, while the switches are controlled by a plurality of three-way valves; in this operation, either pressurized gas or liquid is used. (NSA of Japan)

**30874** MIKROTRON. (Microtron). Kapitsa, S. P.; Melekhin, V. N. Moscow, Izdatel'stvo Nauka, 1969. 212p.

The first chapter deals with the design and construction of microtrons (cyclic accelerators of relativistic electron beams of 5 to 50 MeV energy. Theory of phase oscillations in a microtron, numerical calculation of injection, particle motion, and the theory of vertical and radial focusing are discussed in the following three

chapters. The influence of magnetic field in homogeneity on electron motion is considered. The fifth chapter describes the construction, operation, and performance of microtrons in USSR and the concepts for selection of the most efficient super high frequency microtron systems. Physical characteristics, power specifications and estimates of maximum current, shape of clusters, and beam focusing in a microtron are discussed in the sixth and seventh chapters. The eighth chapter deals with basic characteristics and calculations for continuous operation of microtrons. 92 references. (R.V.J.)

**30875** BIG MACHINE. Jungk, R. London, Andre Deutsch, 1969. 252p. 30s.

Translated from German by G. M. Spruch and T. Wess.

An account is given of the CERN project from its pioneer days to its present international status. (UK)

**30876** THE ISOCHRONOUS CYCLOTRON OF THE UNIVERSITY OF MARYLAND. Delphin, P. Ann. Radioelec., 23: 307-26 (Oct. 1968). (In French).

The isochrone cyclotron of the University of Maryland was designed and manufactured by CSF and Raytheon in three years. This 400-ton machine, derived from that produced by CSF for the University of Grenoble, is the most powerful in the world. A thorough study of the magnetic field, injection, extraction, and high frequency system has led to the design of a cyclotron with many unique features, capable of accelerating protons up to 140 MeV, the $\alpha$ particles to 180 MeV, the deuterons to 90 MeV, the four time ionized carbons to 250 MeV and other heavy particles in wide ranges of energy. This machine consists of 4 highly spiralled magnetic segments and two accelerating electrodes with an aperture of 90°, which permit using harmonics 1, 2, and 3 of the frequency of rotation of the particles. The bandwidth of the radio frequency system (9.5 to 23 MHz) is sufficient to cover very large energy variations in a continuous way. The two radio frequency networks driven by a highly stable synthesizer deliver a power of $2 \times 200$ kW to the resonant cavities. These cavities, of a unique design, provide a frequency variation higher than one octave by mere rotation of a tuning flap rotating without any contact inside the resonant enclosure. The very wide performance of this machine makes it a powerful research tool both for medium energy nuclear physics and for chemistry and biology. (auth)

**30877** TRANSPORT MODEL FOR CONVERTING CHARGED SPECIES IN DRIFT TUBES. Woo, Shien-biau; Whealton, John H. (Univ. of Delaware, Newark). Phys. Rev., 180: 314-19(Apr. 5, 1969).

The three-dimensional transport equations of converting charged species are solved, taking into consideration the effect of the following for both primary and secondary species: different electron and/or ion temperatures, different initial radial distributions, an absorbing drift-tube wall, and the distinction between radial and axial diffusion coefficients. The solution bears explicit dependence on all the relevant geometries of the drift-tube assembly, making it applicable to all known types of drift-tube arrangements. Three realistic initial charge distributions are considered. Remaining inadequacies of this transport model are critically examined. (auth)

**30878** MONOENERGIZING AND FOCUSING OF CHARGED-PARTICLE BEAM IN CYLINDRICAL CAPACITOR ELECTRIC FIELD. Andreev, I. S.; Nazyrov, E. N. (Tashkent State Univ.). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 72-5(1968). (In Russian).

Monoenergizing and focusing effects of cylindrical capacitors on charged particle beams are estimated. It is shown that in addition to the monoenergizing and focusing effects, cylindrical capacitors eliminate the undesirable photoelectric effects produced by charged particles in a target and relieved charged particle beams from the presence of neutral atoms. The distribution of gas-discharge ions extracted from plasma was studied using the cylindrical capacitor. Data obtained reveal the presence of various energy ions (ranging to 1200 eV). (R.V.J.)

**30879** POSSIBILITY OF OBTAINING MONOCHROMATIC $\gamma$-RAY QUANTA BY METHOD OF POSITRON ANNIHILATION IN FLIGHT IN CYCLIC ACCELERATORS. Didenko, A. N.; Talankin, S. A.; Vorob'ev, S. A.; Kuz'min, V. N. At. Energ. (USSR), 26: 440-4(May 1969). (In Russian).

The possibility of obtaining almost monochromatic photon beams by the method of electron–positron annihilations in flight is discussed. The use of an electron synchrotron for this purpose increases the intensity of photon beams. (auth)

**30880** RULES AND INHIBITION OF RADIOLYTIC CORROSION IN THE COPPER COOLING WATER CIRCUITS OF PROTON ACCELERATORS. Hoyer, F. (CERN, Geneva). Atompraxis, 15: 104-8(Mar.-Apr. 1969). (In German).

Corrosion of copper tubes in cooling water circuits of proton accelerators by radiolytic products of water was examined by means of a circuit simulator placed in the proton beam. During irradiation the concentration of copper ions in solution increases as the square root of irradiation time ($C = A\sqrt{t}$). The respective increase without irradiation is only as the fourth root of time ($C' = A'\sqrt[4]{t}$). From experiments for corrosion inhibition, benzotriazole was found to be most effective giving as well a long lasting radiation-resistant passivation of copper surfaces in the real circuit. (auth)

**30881** NEUTRON DEBYE-SCHERRER DIFFRACTION WORKS USING A LINEAR ELECTRON ACCELERATOR. Kimura, M.; Sugawara, M.; Oyamada, M.; Yamada, Y.; Tomiyoshi, S.; Suzuki, T.; Watanabe, N.; Takeda, S. (Tohoku Univ., Sendai). Nucl. Instrum. Methods, 71: 102-10(1969).

Neutron diffraction patterns were obtained by the time-of-flight method using Tohoku linac for the case of powdered samples as well as for single crystals. Thermal neutron beams of 35–50 $\mu$sec pulse width were obtained by poisoned water moderator. Powder patterns of Al at different temperatures have shown many lines of high indices, which enabled to calculate the Debye temperature with considerable accuracy. Several other powdered samples including Si, ZnO were also examined. Magnetic peaks of $\alpha-Fe_2O_3$, $CaFe_2O_4$ were identified. Count collecting time of 2 or 3 h was enough to reach the reliability R to the level of a several percent. High index lines appeared very conspicuously, in contrast to the reactor-chopper results. The fwhm of the diffraction lines was 2.0–1.5% in case the scattering angle $2\theta$ was 90°. It depended on the energy of diffracting neutrons, becoming smaller for neutrons of wavelength shorter than 1 Å, that is for higher index lines. (auth)

**30882** MAGNETIC CONTRACTOR MECHANISM IN BETATRONS AND SYNCHROTRONS. Panaitescu, I.; Isbasescu, M. (Inst. of Atomic Physics, Bucharest). Nucl. Instrum. Methods, 71: 93-8(1969).

A comparative study of different types of magnetic transients (contractors and magnetic bumps), carried out on the 8-MeV betatron of the Institute of Atomic Physics, showed that their mechanism of operation cannot be thought of as a simple orbit contraction, but merely as a convenient means of altering the parameters of the collision between the injected beam and the chamber walls. The actual orbit radius contraction was found experimentally much lower than the one necessary for the electrons to miss the injection gun. Moreover, a similarity of effects of contractor-type transient and the sectorial magnetic bump was pointed out, although the former does contract the orbit and the latter does not. These facts fit best with the central shift mechanism (CSM) theory of electron capture. The effect of relative injection and contraction timing was also studied and conclusions were drawn on the higher efficiency of injecting electrons with instantaneous radii near the equilibrium radius, and on the most convenient form of contractor pulse. (auth)

**30883** A METHOD FOR THE RESONANCE-FREE, LOW-LOSS, BEAM EXTRACTION FROM CYCLOTRONS. Mahrt, R.; Boettger, O. (AEG-Telefunken Research Inst., Frankfurt am Main). Nucl. Instrum. Methods, 71: 45-55(1969).

A survey is given of the effects of magnetic field imperfections on the particle beams in a cyclotron. By suitable combinations of field imperfections of the first and second harmonic it is possible to increase the distance of the orbits and, at the same time, to separate originally overlapping beams. In this way one can have the septum of an electric deflector for further beam separation positioned in an interval between two beams. Hence the septum material will not be exposed to the particle beam. The field regions beyond the radial resonance are avoided. Therefore the described method is uncritical, admits extraction out of cyclotrons with variable specific energy per nucleon, and keeps the axial height of the beam within resonable values. An estimation of the phase width and of the energy spread, admissible for single turn extraction, is given. A special arrangement of field imperfections as well as the results of a Runge–Kutta computer-run are given. (auth)

**30884** EXPERIMENTAL STUDY OF A SLIT MONOPLASMATRON ION SOURCE. Moutinho, A.; Ikelaar, P. G.; Los, J.; Kistemaker, J. (FOM Instituut voor Atoom- en Molecuulfysica, Amsterdam). Nucl. Instrum. Methods, 71: 56-60(1969).

In developing a monoplasmatron ion source with slit geometry the influence of several parameters on the ion emission characteristics was studied. The largest improvements were obtained

by the reduction of the distance intermediate electrode-anode and the area of the intermediate electrode opening. Using the optimal parameters the source yields a protuding plasma that fills partially the anode cup. (auth)

**30885** BEAM MATCHING WITH QUADRUPOLE LENSES. Lee-Whiting, G. E. (Chalk River Nuclear Labs., Ont.); Bezic, N. Nucl. Instrum. Methods, 71: 61-70(1969).

Necessary and sufficient conditions are derived for the simultaneous matching by a quadrupole lens of the phase-space ellipses corresponding to motions in two orthogonal directions perpendicular to the beam direction. The properties of the quadrupole lenses enter the equations only through the focal lengths and the principal-plane positions for the equivalent Gaussian thick lenses. Some special properties of symmetric and antisymmetric systems are discussed. (auth)

**30886** A NANOSECOND-PULSING SYSTEM FOR HEAVY IONS WITH A HVEC TANDEM ACCELERATOR. Jaeschke, E.; Reichardt, W.; Ischenko, G.; Frosch, D.; Huber, B.; Rinsdorf, E. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods, 71: 29-39 (1969).

A pulsing system for a HVEC tandem accelerator capable of producing pulses of protons, deuterons and especially heavy ions up to mass 16 with pulse widths of about one nsec is described. The system is a combination of a pre-injection klystron buncher and a post acceleration chopper. For test purposes the system was used for measuring the half life of the 137 keV level in $^{57}Fe$ following Coulomb excitation ($T_{\frac{1}{2}} = 8.5 \pm 0.4$ nsec) and for performing mass analysis of $^{10}B(^{16}O,X)Y$ heavy ion reactions. (auth)

**30887** SHIELDING OF HIGH ENERGY PARTICLE ACCELERATORS. Hoffmann, L. (CERN, Geneva). Kerntechnik, 11: 204-11(Apr. 1969). (In German and English).

Aspects on the shielding of the shielding of high-energy accelerators and their ejected beams are reviewed. A description of the nucleon-meson cascade is given and the problems connected with the transversal shielding are discussed. Experimental values are compared with the results of Monte Carlo calculations. The conception of shielding layouts are described and the essential problems at higher energies (300 GeV) are summarized. (auth)

**30888** RADIATION SHIELDING FOR THE ELECTRON LINEAR ACCELERATOR OF THE CENTRAL BUREAU FOR NUCLEAR MEASUREMENTS. Horstmann, H. (Zentralbuero fuer Kernmessungen, Geel, Belgium). Kerntechnik, 11: 212-18(Apr. 1969). (In German and English).

Radiation shielding for an electron linear accelerator used as a pulsed neutron source is discussed. The dimensioning of the shielding required for the resonance and fission neutrons and for the gamma radiation of an uranium target is discussed in detail. (auth)

**30889** COAXIAL ELECTRON ACCELERATOR FOR IRRADIATION OF CABLE INSULATORS. Muminov, V. A.; Sudarev, Yu. S. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 50-2(1968). (In Russian).

Descriptions are given of the design and performance of a direct action accelerator with a maximum uniform field space during irradiation of cable insulators. The accelerator is equipped with a 250 keV irradiation tube in which electrons are accelerated between two-coaxial electrodes. The electrons are accelerated by an electrostatic field up to 250 keV and bombard the polyethylene cable insulators. Irradiation of wires revealed improved thermomechanical and electric properties of the insulator after irradiation. (R.V.J.)

**30890** SYNCHROCYCLOTRON PROTON BEAM WITH AN ENERGY OF 100 to 200 MeV FOR MEDICO-BIOLOGICAL INVESTIGATIONS. Dzhelepov, V. P.; Komarov, V. I.; Savchenko, O. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Med. Radiol., 14: No. 4, 54-8(Apr. 1969). (In Russian).

For the purpose of creating conditions for medico-biological investigations a proton beam with an energy of 90 to 185 MeV was passed into an isolated specially equipped premise. The technique is described in detail. (auth)

**30891** PROTON BEAM OF ITEP ACCELERATOR FOR RADIUM THERAPY. Khoroshkov, V. S.; Barabash, L. Z.; Barkhudaryan, A. V.; Goldin, L. L.; Lomanov, M. F.; Onosovskii, K. K.; Plyashkevich, L. N. (Inst. of Theoretical and Experimental Physics, Moscow). Med. Radiol., 14: No. 4, 58-62(Apr. 1969). (In Russian).

A system of extraction of the 200 MeV proton beam for medical and biological purposes from ITEP 7 GeV proton synchrotron was developed. The preliminary results of measurement of the beam characteristics are given. (auth)

**30892** ACCELERATION OF LITHIUM IONS IN A CYCLOTRON. Vasil'ev, P. I.; Venikov, N. I.; Zevyakin, D. V.; Ogloblin, A. A.; Khaldin, N. N.; Khoroshavin, B. I.; Chuev, V. I.; Chumakov, N. I. (Atomic Energy Inst., Moscow). Nucl. Instrum. Methods, 71: 201-4(1969).

Some problems in the acceleration of multicharged lithium ions have been overcome to a sufficient degree at the 1.5-m cyclotron of the Kurchatov Atomic Energy Institute. An intensive source of lithium ions using the arc-discharge in the vapor of metallic Li, has been designed. The external beam intensity of $^6Li^{2+}$ and $^7Li^{2+}$ up to 8 $\mu$A with energy up to 36 MeV as well as that of $Li^{3+}$ up to 0.1 $\mu$A with energy of 60 MeV has been obtained. A great number of experiments have been carried out to study nuclear reactions with accelerated ions of Li. (auth)

**30893** STANFORD TWO-MILE ACCELERATOR. Neal, R. G. (ed.). New York, W. A. Benjamin, Inc., 1968. 1179p.

After a brief introduction of the administrative policies, aims and purposes, historical development, and administrative organization of the Stanford Linear Accelerator Center a general description of the linear accelerator and the SLAC facilities is presented. The design, fabrication, and performance of the various components of the facility are thoroughly examined. Chapters are included on beam dynamics, beam injector, drive system, klystrons, waveguides, phasing system, modulators, trigger system, instrumentation and control, positron source, beam switchyard design and operation, beam switchyard magnets, instrumentation and electronics in the beam switchyard, beam power absorption devices, protection systems, support and alignment, vacuum systems, cooling-water systems, electrical power systems, shielding and radiation, and the physical plant. (B.G.D.)

**30894** PRINCIPLES OF PARTICLE ACCELERATORS. Persico, Enrico; Ferrari, Ezio; Segre, Sergio E. New York, W. A. Benjamin, Inc., 1968. 309p. $17.75.

After a brief review of the different types of particle accelerators and the principles relating to relativistic dynamics, phase stability, and ion sources is presented each type of accelerator is examined thoroughly. Two appendices are included on magnetic quadrupole lenses and the transport of secondary beams. A bibliography of forty-five references is also included. (B.G.D.)

**30895** FABRICATION OF NIOBIUM RF CAVITIES. Meyerhoff, R. W. (Union Carbide Corp., Indianapolis). J. Appl. Phys., 40: 2011-14(Apr. 1969).

From Applied Superconductivity Conference, Gatlinburg, Tenn. See CONF-681057.

A new process for fabricating niobium rf cavities for use in beam separators and linear accelerators is described. The best performance to date for a cavity made by this process was obtained with a $TE_{011}$ mode cavity, operating at 11.2 GHz at a peak magnetic field of ~500 G, for which $Q \approx 2 \times 10^{10}$. The principal advantages of the process described over other methods of fabricating niobium rf cavities are the following. First, a multiplicity of integrally connected cavities can be fabricated in a single joint free section. Second, the finished niobium cavities have a very high-quality surface finish which is produced without the need of mechanical or chemical polishing of the cavities after fabrication. Third, the niobium in the completed cavity is ultrapure and thus has an extremely low normal state resistance at liquid helium temperatures. Fourth, a high thermal conductivity between the niobium on the inside of the cavity and the surrounding liquid helium bath can be obtained when the niobium is supported with porous tungsten. (auth)

**30896** A POLARIZED $^3He^+$ ION SOURCE. Findley, D. O.; Baker, S. D.; Carter, E. B.; Stockwell, N. D. (Rice Univ., Houston). Nucl. Instrum. Methods, 71: 125-32(1969).

A source of polarized $^3He^+$ ions has been constructed and tested. An optical pumping technique is used to polarize the nuclear spins of the ions, which are extracted in the manner of an rf ion source of conventional design. In a nuclear double scattering experiment, a polarization of 0.05 was observed in the ion beam with an intensity of 4 $\mu$A and an emittance of 1 cm · rad · $eV^{\frac{1}{2}}$. (auth)

**30897** SOURCE OF POLARIZED ELECTRONS. Baum, G.; Koch, U. (Univ., Bonn). Nucl. Instrum. Methods, 71: 189-95(1969).

Investigations on a source of polarized electrons intended for use in an accelerator are reported. An intense potassium atomic beam is polarized to a degree of 0.8 by a magnetic six-pole field.

The valence electrons are set free by ultraviolet light of a Xe flash tube. The polarization P of the photoelectrons is measured by Mott scattering at 120 keV. P = 0.55 ± 0.05 was obtained. The intensity of the source is $10^7$ electrons/pulse with a pulse length of 20 μsec. The maximum possible repetition rate is 50 Hz and will result in $5 \times 10^8$ electrons/sec. With a Li atomic beam and improved lamp operation an intensity increase by a factor of 50 is expected. (auth)

**30898** MODIFICATION OF RF OSCILLATOR FOR HIGH PRESSURE OPERATION. Bennett, G. L.; Copple, W. P.; Knowles, H. B. (Washington State Univ., Pullman). Nucl. Instrum. Methods, 72: 1-4(1969).

Inability to operate a commercial rf ion source (which incorporated the RCA 8072 tetrode in its oscillator) at pressures in excess of 20 atm prompted investigation of all pressure-sensitive components. The principal point of vulnerability was found to be in the tetrode. A device for correcting this weakness is described, which permits stable ion source operation at 25.5 atm. (auth)

**30899** SYNCHROTRON OSCILLATIONS IN HIGH-ENERGY SYNCHROTRONS. Piwinski, A. (DESY, Hamburg). Nucl. Instrum. Methods, 72: 79-81(1969).

At very high energies the synchrotron frequency can be of the same order as the revolution frequency. For this case the synchrotron oscillation is investigated for a ring structure subdivided into discrete sections with acceleration and synchrotron radiation, respectively. A more correct value for the synchrotron frequency and the bunch dimensions and also a limit for the stability of the frequency of the linearized synchrotron oscillation is obtained. (auth)

**30900** LOW-BACKGROUND BEAM DEFINING SLITS. Roy, G.; Riebeek, N. (Univ. of Alberta, Edmonton). Nucl. Instrum. Methods, 71: 234-6(1969).

A slit mechanism for scattering chambers is described which allows independent positioning in the vertical and horizontal directions. Following our alignment technique, insignificant background is observed from the slit system. (auth)

**30901** ORBIT DYNAMICS OF ISOCHRONOUS CYCLOTRONS WITH SEPARATE HOMOGENEOUS FIELD MAGNETS. Schatz, G. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 72: 29-34(1969).

Explicit expressions are derived for the orbit properties of isochronous cyclotrons with separate homogeneous field magnets by use of the matrix method and the hard edge approximation. The results hold for arbitrary shapes of the magnet boundaries (subject to the condition of isochronism). As a design example a 50 to 310 MeV proton accelerator is considered in more detail. (auth)

**30902** ENERGY MEASURING DEVICE FOR EXTERNAL CYCLOTRON BEAMS. Micheletti, S.; Giannini, G. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Nucl. Instrum. Methods, 71: 153-6(1969).

An energy measuring device to be used on cyclotron beams is described. The instrument is based on a combined measurement of particle range and energy loss. A long term reproducibility of a few keV and a sensitivity of less than 0.01% are obtained. (auth)

**30903** THIN PARALLEL-WALLED LIQUID HYDROGEN TARGET. Polucci, G. M. (Harvard Univ., Cambridge, Mass.); Koehler, A. M.; Palmieri, J. N. Nucl. Instrum. Methods, 71: 218-20(1969).

A liquid hydrogen target is described whose one-inch thickness is uniform within 0.002 inch over a three-inch diameter. (auth)

**30904** BEAM ANALYZING SYSTEM FOR A VARIABLE ENERGY CYCLOTRON. Hintz, R. E.; Selph, F. B.; Flood, W. S.; Harvey, B. G.; Resmini, F. G.; McClatchie, E. A. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 72: 61-71(1969).

A new beam analysis system has been installed at the Berkeley 88″ cyclotron. The system consists of two 110° flat field, edge focusing bending magnets. The first magnet is used to energy analyze the cyclotron beam, and the second or "clean up" magnet is used to remove slit scattered particles produced by the analyzing magnet. The system has achieved its design performance of 0.02% energy resolution, with a long term stability of two parts in $10^5$. Up to 0.6 μA of a beam with a radial emittance of 4.5 mm · mrad has been obtained with the above energy resolution. The design, construction, installation shimming and testing of the magnets are described as well as the construction of the regulated power supply. (auth)

**30905** BUTANOL POLARIZED PROTON TARGET. Mango, S.; Runolfsson, Oe.; Borghini, M. (CERN, Geneva). Nucl. Instrum. Methods, 72: 45-50(1969).

Dynamic proton polarizations around 40% have been reproducibly obtained in 5 $cm^3$ samples made of 95% 1-butanol and 5% water mixtures, saturated with the free radical porphyrexide, at temperatures close to 1°K in a magnetic field of 25 kOe. (auth)

**30906** RAPID TRANSFER SYSTEM FOR THE STUDY OF CYCLOTRON-ACTIVATED SHORTLIVED ISOTOPES. Jongsma, H. W.; Verheul, H. (Vrije Univ., Amsterdam). Nucl. Instrum. Methods, 72: 51-5(1969).

With an automatically driven pneumatic transfer system ("rabbit system") irradiated targets can be transferred from the irradiation position in the external beam of an AVF cyclotron over a distance of 75 m to the separation or radiation detecting equipment within 6 sec. (auth)

# PHYSICS (NUCLEAR)

## Neutron Interactions with Matter

*Refer also to abstract 29251, 29515, 30599, 30608, 30881, and 31223.*

**30907** (AEEW-M-833) MONTE CARLO CALCULATIONS OF NEUTRON AGE IN SOME MODERATING MEDIA. Veale, M. (Atomic Energy Establishment, Winfrith (England)). July 1968. 10p. Dep. CFSTI. UK.

A brief description is given of a Monte Carlo code written to determine the neutron age in a homogeneous medium, and its subsequent use in resolving certain discrepancies in age calculations, especially in light water is described. The code utilizes the DICE structure and is a by-product of a larger Monte Carlo project. (auth)

**30908** (CCDN/SYS-2) NEUDADA SYSTEM DESCRIPTION. (European Nuclear Energy Agency, Paris (France)). Apr. 1969. 73p. Dep.

NEUDADA allows a wide range of neutron or other numerical data to be stored in a compact standard format and retrieved in direct access. It accepts input data according to the relatively restricted SCISRS 1 specifications, and allows retrieval in one of three special purpose output formats, while large data sets in formats other than SCISRS 1 are converted directly to the NEUDADA internal format by the generalized TONDADA conversion program. Keywords identifying data sets, comments and numerical data are organized in three files: a relatively short index similar to the CCDN's fourth Newsletter controls direct access to the larger comment and numerical data stores. The system is divided into programme modules of the size most suitable to the CCDN's small computer: this organization, and the use of a high-level language (PL/1) in conjunction with manufacturers' standard software, should make it possible to transfer the system to other modern computers with very little loss of efficiency. (auth)

**30909** (GEMP-620) FORTY-GROUP CROSS SECTION FOR MONTE CARLO CALCULATIONS. Zwick, J. W. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). Jan. 30, 1968. 98p. Dep. CFSTI.

Neutron cross sections of a number of elements were prepared in a 40-group format for use in GE-NSP Monte Carlo Programs 80-0 and FMC-N. The 40 groups span the energy range from 10,000 eV to 14 MeV. The cross section point values and the resulting group end-point values of the cross sections are given for H, Be, B-10, O Na, Al, Cr, Fe, Ni, Mo, and Cd. Group-averaged cumulative angular distribution tables are given for Be, B-10, O, Al, and Cd. Included are the elastic scattering differential cross sections or Legendre coefficients from which the cumulative angular distribution functions were prepared. The sources of the cross section data and the averaging procedure are briefly discussed. (auth)

**30910** (LA-DC-9756) TAILORED SPECTRA FROM 14 MeV SOURCES. Smith, Darryl B.; Menlove, H. O. (Los Alamos Scientific Lab., N. Mex.). [nd]. 4p. (CONF-681101-27). Dep. CFSTI.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

Neutron transport calculations using the DTF-IV transport code have been directed toward maximum neutron leakage and desired spectral characteristics from various moderator assemblies. Calculations (one space dimension) were performed with a 14-MeV neutron source at the center of moderating assemblies consisting of concentric shells of various materials with varying radii. (auth)

**30911** (LA-DC-9762) CALCULATION OF DELAYED NEUTRON MULTIPLICATION IN THIN SUBCRITICAL SYSTEMS. Lee, Clarence E.; Masters, Christopher F. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 5p. (CONF-681101-23). Dep. CFSTI.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

The DTF-IV transport code, modified to incorporate the Zero Prompt Lifetime Approximation, was used to calculate the delayed neutron multiplication in thin subcritical systems of $^{235}U$ and $^{238}U$. (J.W.R.)

**30912** (RPI-328-148, pp 39-47) LOW ENERGY NEUTRON INELASTIC SCATTERING (LENIS). (Rensselaer Polytechnic Inst., Troy, N. Y.).

Progress on low-energy neutron inelastic scattering studies in the period Oct. 1, 1968, to Dec. 31, 1968, is reported. The studies include the uranium monocarbide scattering law, Monte Carlo multiple scattering code, inelastic scattering in water, and the natural uranium monocarbide total cross section. (J.W.R.)

**30913** (RPI-328-155) A MONTE CARLO CODE FOR NEUTRON CAPTURE EXPERIMENTS. Sullivan, J. G.; Warner, G. G. (Oak Ridge National Lab., Tenn.); Block, R. C.; Hockenbury, R. W. (Rensselaer Polytechnic Inst., Troy, N. Y.). [nd]. Contract AT-(30-3)-328. 39p. Dep. CFSTI.

A Monte Carlo code for calculating neutron capture cross sections is described. The cross-section formula used is discussed and the program outline and flow chart are given. (J.W.R.)

**30914** CONSTRUCTION AND TECHNOLOGY OF FAST NEUTRON GENERATOR TUBES. Bobrowski, Cz.; Chrusciel, E.; Massalski, J.; Starzec, A. (Academy of Mining and Metallurgy, Krakow). Pol. Tech. J., 11: 1327-33(1967). (In Polish).

The construction and operation principle of neutron generator tubes designed for geophysical purposes and activation analysis is described. The influence of ion source parameters on the ion current and consequently on neutron output is discussed. The output obtained with geophysical tubes was $10^8$ n/sec order. On the basis of the measurements of ion current, which mainly consists of monoatomic ions it is expected that the output of the neutron tube designed for activation analysis will be $10^{10}$ n/sec order. (auth) (NSA of Poland)

**30915** NEUTRON SPECTRUM OF $^{238}PuF_4$. Herold, T. R. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Nucl. Instrum. Methods, 71: 40-4(1969).

The neutron spectrum of $^{238}PuF_4$ was measured with $^6Li$ and $^3He$ fast neutron spectrometers. The neutrons derive mainly from the $(\alpha,n)$ reaction with $^{19}F$. The spectrum shows a peak at 1.2 MeV and a maximum neutron energy of ≈3.1 MeV. (auth)

**30916** A SIMPLE METHOD OF INCREASING THE MOSAIC SPREAD OF GERMANIUM NEUTRON MONOCHROMATORS. Nikotin, O. P. (Danish Atomic Energy Commission Research Establishment, Riso). Nucl. Instrum. Methods, 72: 77-8(1969).

A description is given of a hot pressing method for increasing the mosaic spread of germanium monocrystals up to 2°. (auth)

**30917** MULTIPLE SCATTERING AND ABSORPTION OF THERMAL NEUTRONS IN THIN TARGETS. Choudry, A. (Univ. of Rhode Island, Kingston). Nucl. Instrum. Methods, 71: 221-5(1969).

A thermal neutron beam of rectangular cross-section is incident obliquely upon a thin rectangular target. A technique, whose first step is a Monte Carlo calculation, is developed to calculate the number of neutrons that are captured in the target or leave it, after having suffered n = 1,2 . . . elastic collisions. This information is needed to correct experimentally measured values of neutron capture and total cross-sections. It is further shown that once having done the Monte Carlo calculation for a typical case, one can predict the same information for diverse beam and target geometries and target material, without having to repeat the time consuming Monte Carlo calculation. (auth)

**30918** RESOLUTION OF A SYSTEM OF INTEGRAL EQUATIONS FOR MONOENERGETIC NEUTRON SCATTERING BY THE METHOD OF SOLUTION KERNELS. I. Draganu, Mircea (Univ., Cluj). Rev. Roum. Math. Pures Appl., 13: 307-17(1968). (In French).

The scattering equation is found in the case of monoenergetic neutrons from the method of solution kernels applied to a system of integral equations. The general form of the integral equations in the case of anisotropic scattering, an alternative method of establishing the system of integral equations, and the development of kernels of integral equations in the absence of sources are considered. (J.F.P.)

**30919** RESOLUTION OF A SYSTEM OF INTEGRAL EQUATIONS FOR MONOENERGETIC NEUTRON SCATTERING BY THE METHOD OF SOLUTION KERNELS. II. Draganu, Mircea (Univ., Cluj). Rev. Roum. Math. Pures Appl., 13: 439-50(1968). (In French).

Functions are studied which appear in the calculation of the coefficients of a system of algebraic equations, from which a system of integral equations is derived. Also a property of the coefficients and functions of the system is indicated. (tr-auth)

# Nuclear Properties and Reactions, A≤ 5

*Refer also to abstracts 29212, 30700, 30763, 30764, 30955, and 30997.*

**30920** (BMwF-FBK-68-51) ANNUAL REPORT, 1967. (Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany)). Nov. 1968. 212p. (In German). Dep.

The report contains the following parts: Annual Report of the Tandem Laboratory, Annual Report of the Cyclotron Laboratory, Annual Report of the Nuclear Spectroscopy Group, Annual Report of the external guest groups of the MPI, and List of publications 1967. Period covered by the report is: Jan. 1st–Dec. 31st, 1967. (auth)

**30921** (BMwF-FBK-69-4) ANNUAL REPORT, 1967. (Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Feb. 1969. 88p. (In German). Dep.

Research at Physikalisches Staatsinstitut–II. Institut für Experimentalphysik, Hamburg-Bahrenfeld, includes experimental and theoretical studies in the fields of nuclear and high energy physics. Concerning nuclear physics investigations, stress is laid mainly on nuclear spectroscopy and the study of reaction mechanism. These experiments are performed with a 3 MeV van de Graaff generator and by means of radioactive sources. High energy physics is investigated especially by analysis of photographs taken in the bubble chambers and by studies of production processes of elementary particles, both in connection with Deutsches Elektronen-Synchrotron (DESY). (auth)

**30922** (KFK-829) CALCULATION OF THE MASS VALUE FOR ATOMIC NUCLEI WITH A ≤ 80. Behrens, H.; Jaenecke, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Sept. 1968. 53p. (In German). Dep.

A table of masses of proton and neutron rich nuclei with A ≤ 80 is presented. For the calculation of the table a relation was used which makes it possible to estimate the excitation energies of isospin analog states. The excitation energies can be described approximately by a T dependence of the form T(T + 1). The singularities of the calculation are described. (tr-auth)

**30923** (RHEL/R-170) P.L.A. PROGRESS REPORT, 1968. Batty, C. J. (ed.) (Rutherford High Energy Lab., Chilton (England)). Nov. 1968. 166p. Dep. CFSTI. UK 20s.

An account is given of the Proton Linear Accelerator machine operation and development, including various improvements. Proton scattering studies are described, together with studies on proton induced reactions. The report also describes some theoretical studies; also experimental techniques, and health physics matters. An outstanding facility of the PLA is the polarized proton source; studies with this have included precision measurement of the angular distribution of polarization in elastic scattering. A technique was also developed for the study of elastic scattering of polarized protons at backward angles (up to 175°); results for carbon indicate that there is a large and rapid reversal of polarization (−70% to +100%) in the region of 150° to 160°. Oxygen also shows the same effect, but not in quite as marked a manner. Reference is also made to the TRIUMF project, the aim of which is to build a 500 MeV variable energy cyclotron on the University of British Columbia campus; the accelerator design is based on a proposal which utilises negative H-ions to achieve the variable energy feature and 100% extraction efficiency. An important study in this connection was the stripping of the $H^-$ ion in a magnetic field, for which accurate values are essential. A list of publications by the PLA staff and by visitors is appended. (auth)

**30924** SCATTERING OF POLARIZED NEUTRONS BY $^3$He. Buesser, F. W.; Dubenkropp, H.; Niebergall, F.; Sinram, K. (Institut fuer Experimentalphysik, Hamburg). Nucl. Phys., A129: 666-72(1969).

The asymmetry in elastic scattering of partially polarized neutrons by $^3$He was measured at neutron energies of 12 and 16 MeV as a function of the scattering angle. The $^{12}$N(d,n$_0$)$^{16}$O and $^3$H(d,n)$^4$He reactions were used as sources of polarized neutrons. The polarization of the incident neutrons was deduced from measurements of the asymmetry in n-α scattering, so that the polarization in n-$^3$He scattering could be evaluated. The results are discussed in the framework of a tentative phase-shift analysis. (auth)

**30925** INVESTIGATION OF THE REACTION $^4$He($^4$He,$^4$He)$^4$He* AT 64 MeV. Gross, E. E. (Oak Ridge National Lab., Tenn.); Hungerford III, E. V.; Malanify, J. J.; Pugh, H. G.; Watson, J. W. Phys. Rev., 178: 1584-90(Feb. 20, 1969).

The reaction $^4$He($^4$He, $^4$He)$^4$He* was investigated, using a 64-MeV α-particle beam. Absolute differential cross sections for the state near 20-MeV excitation are reported for the angular range $12.5° < \theta_{cm} < 74°$. The excitation energy of this state was measured to be 20.28 ± 0.05 MeV and the width to be 0.41 ± 0.05 MeV. The shape and position of this state are shown to be consistent with an analysis based on the known properties of low-energy p-$^3$H scattering. (auth)

**30926** TWO-BODY EQUATIONS FOR FOUR-NUCLEON PROBLEMS. Van Dyke, Peter; Folk, Robert (Lehigh Univ., Bethlehem, Pa.). Phys. Rev., 178: 1537-42(Feb. 20, 1969).

The variational principle for the energy is used to derive integrodifferential equations for the two-body functions which, when combined in the product form, yield the "best" independent-pair wave function for the α particle. A practicable interaction procedure for finding approximate solutions to these equations is developed and is used to obtain an approximate ground-state wave function, for an example, four-body Hamiltonian for which the potential is central. Improvements in the interaction procedure are described which make it a feasible method for solving the integrodifferential equations even when tensor forces are included. (auth)

**30927** NUCLEON CORRELATION EFFECT IN THE SHELL-MODEL DESCRIPTION OF THE DEUTERON. Lodhi, M. A. K. (Texas Technological Coll., Lubbock). Phys. Rev., 178: 1590-3(Feb. 20, 1969).

It was assumed that an effective central potential in place of actual N-N interaction can be used in general for finite-nucleus calculations. By introducing, however, a class of residual two-body interactions, the nucleon correlation effect in the independent-particle-model (IPM) wave functions of nuclei was studied. As an illustrative example, this method was applied to the deuteron. A shell-model description of the deuteron is proposed that takes proper account of the nucleon correlation and the residual potential. An adequate agreement with the elastic electron-scattering data was obtained even for the deuteron without using the tensor force. This method should be applicable to many other nuclear problems and result in interesting predictions. (auth)

**30928** PROTON–PROTON BREMSSTRAHLUNG AT $E_p$ = 10 MeV. Niiler, A.; Joseph, C.; Valkovic, V.; Spiger, R.; Canada, T.; Emerson, S. T.; Sandler, J.; Phillips, G. C. (Rice Univ., Houston, Tex.). Phys. Rev., 178: 1621-5(Feb. 20, 1969).

A measurement of the proton–proton bremsstrahlung cross section at $E_p$ = 10 MeV was made. Two silicon surface-barrier detectors were placed in a hydrogen gas target at 30° on opposite sides of the beam axis. The energies of the two final-state protons and their time-of-flight difference were measured. $E_1 - E_2$ spectra corresponding to events in the true and accidental regions of the time spectrum were obtained in off-line analysis. An upper limit of 0.42 μb/sr$^2$ was established for the proton–proton bremsstrahlung cross section at $E_p$ = 10 MeV, $\theta$ = 30°. (auth)

**30929** ELASTIC SCATTERING OF PROTONS BY POLARIZED $^3$He. Baker, S. D.; McSherry, D. H.; Findley, D. O. (Rice Univ., Houston, Tex.). Phys. Rev., 178: 1616-21(Feb. 20, 1969).

Protons from 3.8 to 10.9 MeV were elastically scattered from a $^3$He target polarized by optical pumping. The left-right scattering asymmetries are reported, and construction of the target cell and optical pumping apparatus is discussed. (auth)

**30930** PROTON–PROTON BREMSSTRAHLUNG AT 65 MeV. Mason, D. L. (Oak Ridge National Lab., Tenn.); Halbert, M. L.; van der Woude, A.; Northcliffe, L. C. Phys. Rev., 179: 940-8(Mar. 20, 1969).

Proton–proton bremsstrahlung cross sections were measured for final-state proton angles of (20°, 20°), (20°, 26°), (23°, 30°), (25°, 25°), (25°, 35°), (26°, 35°), (26.5°, 26.5°), and (30°, 30°). Differential cross sections as a function of γ-ray angle were extracted from four sets of data. A theoretical prediction of the (30°, 30°) angular distribution, averaged over the azimuthal acceptance of the counters, agrees well with the experimental result. Total cross sections were obtained at all pairs of angles mentioned and were used to estimate the coplanar cross sections. The coplanar cross sections agree with results of a model-independent soft-photon calculation. They are smaller than predictions made with either a hard-core potential or a momentum-dependent potential, but they favor the latter. (auth)

**30931** PROTON–PROTON BREMSSTRAHLUNG CALCULATIONS. McGuire, J. H. (Northeastern Univ., Boston); Cromer, A. H.; Sobel, M. I. Phys. Rev., 179: 948-57(Mar. 20, 1969).

The pole contribution to the proton–proton bremsstrahlung cross section is shown to give the cross section exactly to order $K^0$, where K is the photon momentum, in the gauge in which the photon polarization $\epsilon^\mu$ has $\epsilon^0 = 0$ in the center-of-mass system. To this order there are no off-energy-shell (OES) contributions. Calculations are presented using the pole contribution only to test the sensitivity of the cross section to the OES effects, which come from higher-order terms in K. The quasiphases which describe the OES behavior of the pp scattering amplitude are parametrized, and the sensitivity of the cross section is studied in terms of this parametrization. The results are compared with calculations based on the Hamada–Johnston potential and with the results of other authors. It is found that for favorable geometries above 50 MeV the variation in this cross section for different OES behavior is sufficient to be measured. This sensitivity comes largely from terms in the magnetic interaction and the tensor and spin-orbit part of the pp interaction. (auth)

**30932** BETA DECAY OF THE FREE NEUTRON. Nielsen, A. (Danish Atomic Energy Commission, Risoe). pp 91-111 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25–28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.

See CONF-670981.

The half-life for beta decay of the free neutron was measured to be 10.8 ± 0.16 min. From this measurement and other data the ratio of axial vector to vector terms in the interaction was determined. (J.W.R.)

## Nuclear Properties and Reactions, $6 \leq A \leq 19$

*Refer also to abstracts 29212, 30214, 30920–30923, 30981, 30996, and 31064.*

**30933** (BMwF-FBK-68-38) ANNUAL REPORT, 1966. (Technische Hochschule, Munich (West Germany). Teilinstitut Maier-Leibnitz im Physikdepartment). Aug. 1968. 257p. (In German). Dep.

In 1966 the following problems were investigated: investigation of the low energy (n,γ) radiation and of conversion electrons after neutron capture, investigation of the average number and energy of β-particles per nuclear fission, exact measurements of scattering lengths for slow neutrons at the gravity spectrometer in order to investigate the neutron-electron interactions, measurement of the slowing down of recoil atoms with the nuclear resonance fluorescence method, change of the properties of crystals by lattice imperfections induced by irradiation, investigation of imperfections and dislocations by scattering of subthermal neutrons, and construction of a totally reflecting guide tube. (auth)

**30934** (PUC-937-359) NUCLEAR PHYSICS PROGRESS REPORT, APRIL 1968–APRIL 1969. (Princeton Univ., N. J.). Contract AT(30-1)-937. 43p. Dep. CFSTI.

The development and operation of the Princeton isochronous cyclotron and the accompanying experimental facilities in the period April 1968 to April 1969 is described. Research on nuclear reactions nuclear theory, and atomic beam studies is also reported. (J.W.R.)

**30935** DWBA ANALYSIS OF THE HEAVY ION-INDUCED TRANSFER REACTION. Kammuri, Tetsuo; Yoshida, Hirosbi (Osaka Univ.). Nucl. Phys., A129: 625-46(1969).

The heavy-ion induced transfer reactions were analyzed using the finite-range DWBA. The following reactions are treated for incident energies near the Coulomb barrier: $^{16}N(^{16}N,^{12}N)^{15}N$, $^{12}C(^{16}O,^{16}O)^{12}C$, $^{11}B(^{16}O,^{15}N)^{12}C$, and $^{27}Al(^{16}O,^{15}N)^{28}Si$. In most cases the transferred particle was assumed to be bound in a harmonic oscillator potential well. Part of the calculations were performed for a simple shell model with the Woods–Saxon potential. Good agreement with experiments can be obtained for reactions involving one-nucleon transfer. For the α-particle transfer process, the calculation shows complicated angular distributions, depending on various parameters. (auth)

**30936** USE OF POLARIZED DEUTERONS TO DETERMINE THE TOTAL ANGULAR MOMENTUM TRANSFER IN STRIPPING REACTIONS. Yule, T. J.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Phys., A117: 1-26(1968). (COO-7-0465).

Polarized deuterons were used to initiate stripping reactions to determine vector analysing powers for transitions for which the orbital angular momentum l and total angular momentum j of the captured neutron are known. Measurements were performed at a deuteron energy of about 8 MeV for the target nuclei $^9Be$, $^{12}C$, $^{24}Mg$, $^{40}Ca$, and $^{52}Cr$. For a given l, there is pronounced difference between the vector analyzing powers for $j = l + \frac{1}{2}$ and $j = l - \frac{1}{2}$ reactions. The measured vector analyzing powers are compared with predictions based on the distorted-wave Born approximation. Effects of variations of optical parameters are discussed. If optical potentials which fit the elastic scattering data are used, the measured vector analyzing powers are reproduced for the intermediate-weight nuclei. (auth)

**30937** ORBITAL REARRANGEMENT IN THE sd-SHELL NUCLEI. Faessler, Amand (Max-Planck-Institut fuer Kernphysik, Heidelberg); Wolter, H. H. Z. Phys., 223: 192-8 (1969).

The single particle orbital rearrangement energy is found to lie between 30 and 50% of the Brueckner arrangement energy in the sd-shell. This calculation shows that the orbital rearrangement energy $R_\alpha$ is in a good approximation equal to half the difference of the single particle energies $\epsilon_\alpha$ in the system with A particles and in the system with A − 1 particles having a hole in the state $|\alpha\rangle$. (auth)

**30938** OPTICAL-POTENTIAL PARAMETERS FOR $^3He$. Zurmuehle, R. W.; Fou, C. M. (Univ. of Pennsylvania, Philadelphia). Nucl. Phys., A129: 502-12(1969).

Angular distributions of elastically scattered $^3He$ at 15 MeV were measured for $^{12}C$, $^{13}C$, $^{16}O$, $^{18}O$, $^{20}Ne$, $^{22}Ne$, $^{24}Mg$, $^{26}Mg$, $^{28}Si$, $^{29}Si$, $^{32}S$, $^{36}Ar$, $^{40}Ar$, $^{40}Ca$, and $^{48}Ca$. Optical-model parameters were determined. (auth)

**30939** THE $(\alpha,2\alpha)$ REACTION ON $^6Li$, $^7Li$, $^9Be$, AND $^{12}C$. II. THEORY. Dolinov, V. K.; Meboniya, D. V.; Tulinov, A. F. (Moscow State Univ.). Nucl. Phys., A129: 597-609(1969).

Experimental results obtained for the one-step channel of the $(\alpha,2\alpha)$ reaction on $^6Li$, $^7Li$, $^9Be$, and $^{12}C$ at $E_\alpha$ = 25 MeV were compared with impulse approximation calculations for the knock-out of an α-cluster from the target nucleus. The effects of going off the mass shell were taken into account; the α–α interaction was described with phenomenological potential parameters deduced from a phase analysis of free α–α scattering. The structure factors were calculated within the framework of the multiparticle shell model with intermediate coupling. For $^6Li$, $^9Be$, and $^{12}C$, satisfactory agreement between theory and experiment was obtained both for the form of the angular correlation functions and for the absolute value of the differential cross section. The assumption of a classical purely "statistical" disintegration of the compound system into three particles without interaction in the final state does not lead to agreement between theory and experiment. (auth)

**30940** THE $(\alpha,2\alpha)$ REACTION ON $^6Li$, $^7Li$, $^9Be$, AND $^{12}C$. I. EXPERIMENTAL DATA. Dolinov, V. K.; Melikov, Yu. V.; Tulinov, A. F.; Bormot, O. V. (Moscow State Univ.). Nucl. Phys., A129: 577-96(1969).

The $(\alpha,2\alpha)$ reaction on $^6Li$, $^7Li$, $^9Be$, and $^{12}C$ nuclei induced by 25 MeV α-particles was studied by two-dimensional energy analysis. Two-dimensional energy spectra were obtained at various angular positions of the detectors in the reaction plane. It is shown that for low-filled distributions, the problem of two-dimensional analysis can be reduced to a one-dimensional analysis. The spectra obtained indicate that the $(\alpha,2\alpha)$ reaction proceeds both through a two-stage channel via known quasi-stationary states of the target nucleus and through a one-stage channel in which all three particles are produced simultaneously. The probabilities of the two processes are comparable; the cross section of the one-stage process decreases with increasing binding energy of the α-particle in the initial nucleus. The α–α angular correlation functions corresponding to the one-stage mechanism were obtained for symmetrical and asymmetrical arrangements of the detectors with respect to the incident beam. (auth)

**30941** PHOTODISINTEGRATION OF $^9Be$. Majling, L. (Nuclear Research Inst., Rez, Czech.); Kukulin, V. I.; Smirnov, Yu. F. Czech. J. Phys., 18: 1560-75(1968).

The absorption spectrum for dipole γ quanta with energies below 35 MeV was calculated using the many-particle nuclear shell model. The cross sections of the partial photonuclear reactions (γ,n), (γ,p), (γ,d) and (γ,α) and the photonucleon spectra were calculated. Spin-orbital interactions were neglected and it was assumed that the residual pairing interaction is well described by Serber forces. The supermultiplet structure of the considered spectrum of excited levels is thus preserved and the matrix of the Hamiltonian decomposes into a number of submatrices having considerably lower order, each of which can be diagonalized separately. This circumstance made it possible to consider states which are not directly excited in γ-quantum absorption,

which however do considerably influence the structure of the absorption curve and especially the decay properties of the excited levels and the spectrum of emitted particles. The agreement with the experimental data is very satisfactory. (auth)

**30942** CROSS SECTIONS FOR $^{7}$Li + $^{7}$Li FROM 2 MeV TO 6 MeV. Carlson, R. R.; Wyborny, H. W. (Univ. of Iowa, Iowa City). Phys. Rev., 178: 1529-36(Feb. 20, 1969).

Differential cross sections for 16 charged-particle groups resulting from the $^{7}$Li + $^{7}$Li nuclear reaction were measured as a function of angle and energy. Measurements were generally made every 10° from 0° to 90° in the laboratory and every 0.75 MeV from 2.10- to 5.75-MeV bombarding energy. This bombarding energy range reaches from well below to well above the classical Coulomb barrier. The general shapes of the angular distributions do not change over the energy range below the barrier, but there are marked changes in some cases for energies above the barrier. A barrier-penetration energy dependence of the total cross sections is found at low energies, but marked deviations from this dependence occur as the barrier is surmounted. The absolute values of the cross sections were measured, and the sum of the total cross sections is decidedly less than the calculated cross section for barrier penetration. (auth)

**30943** TRITON REACTIONS NEAR 2 MeV: ELASTIC SCATTERING. Herling, G. H.; Cohen, L.; Silverstein, J. D. (Naval Research Lab., Washington, D. C.). Phys. Rev., 178: 1551-5 (Feb. 20, 1969).

Tritons were elastically scattered from a number of light nuclei, and the data were analyzed in terms of the optical model. Geometries were found which are applicable to $^{9}$Be, $^{10,11}$B, and $^{12}$C, and to $^{19}$F and $^{20}$Ne. The real central well depths are approximately 140 MeV, and the spin-orbit well depth is greater than that expected from theoretical considerations. Ambiguities in the parameters are discussed. (auth)

**30944** ELASTIC AND INELASTIC ELECTRON SCATTERING FROM NUCLEAR MULTIPOLE MOMENTS IN THE FIRST-ORDER BORN APPROXIMATION. Ueberall, H. (Catholic Univ. of America, Washington, D. C. Naval Research Lab., Washington, D. C.); Uginčius, P. Phys. Rev., 178: 1565-83(Feb. 20, 1969).

Elastic and inelastic scattering of electrons from deformed light nuclei is considered in the Born approximation. For the elastic scattering case, the most general expression for the cross section is developed in terms of the electric and magnetic multipole moments of the nuclear ground state and the corresponding form factors, which are expressed by the (spectroscopic) moments of charge and magnetization distributions. For the inelastic scattering case, the transition form factors are similarly expressed by transition multipole densities of charge, current, and magnetization in the most general fashion. A model of collective vibrations of deformed ground-state charge and magnetization densities is developed which, in the case of charge vibrations, explains present data and predicts the filling in of inelastic diffraction minima; in the case of vibration of magnetization, corresponding transitions are shown to appear at large momentum transfers only, where they may be identified as such by the action of selection rules. In the Appendices, also considered are relations between spectroscopic and intrinsic quantities, static deformed and Helm-type models, and charge and magnetic radii. In addition, the previously derived generalized Helm model is rederived in a simple fashion. (auth)

**30945** PROPERTIES OF THE 3.39-MeV STATE IN $^{12}$B. Mooring, F. P. (Argonne National Lab., Ill.); Monahan, J. E.; Segel, R. E. Phys. Rev., 178: 1612-15(Feb. 20, 1969).

The 3.39-MeV state in $^{12}$B was studied in the $^{11}$B + n system, where the state appears as a resonance at a (lab) neutron energy of 20.8 ± 0.5 keV. Comparison of the neutron scattering and transmission measurements with the $^{11}$B (d, p) data requires that the resonance be d-wave. Various considerations leave 3$^-$ as the only plausible assignment. For a spin of 3, the neutron width is $\Gamma_n$ = 3.1 ± 0.6 eV, which is about equal to the Wigner limit. Neutron-capture measurements, in which the residual $^{12}$B activity was observed, clearly showed the resonance and yielded a total radiation width $\Gamma_\gamma$ = 0.025 ± 0.008 eV. The 18.36-MeV state in $^{12}$C appears to be the $T_z$ = 0 analog of this state. (auth)

**30946** ISOSPIN-FORBIDDEN $^{16}$O(d, $\alpha_1$)$^{14}$N REACTION. Jobst, J.; Messelt, S.; Richards, H. T. (Univ. of Wisconsin, Madison). Phys. Rev., 178: 1663-9(Feb. 20, 1969).

Differential cross sections for the isospin-forbidden reaction $^{16}$O(d, $\alpha_1$)$^{14}$N* are reported for 3 < $E_d$ < 15 MeV for various angles. For 5 < $E_d$ < 9 MeV, data points are 10 to 20 keV apart and at six angles. Many resonances were observed. Detailed angular distributions were taken at some of the resonances and the data interpreted in terms of $^{18}$F states with large isospin mixing. For some of these states, $J^\pi$ assignments were obtained. No evidence appears for any appreciable direct-reaction yield. (auth)

**30947** GENERALIZED PAIRING IN LIGHT NUCLEI. I. SOLUTIONS OF HARTREE–FOCK–BOGOLYUBOV EQUATIONS IN N = Z EVEN–EVEN NUCLEI. Bar-Touv, J. (Univ. of California, Berkeley); Goswami, A.; Goodman, A. L.; Struble, G. L. Phys. Rev., 178: 1670-81(Feb. 20, 1969).

The Hartree–Fock–Bogolyubov (HFB) equations are solved for the N = Z even–even nuclei in the s-d shell. The possibility of generalized pairing correlations (e.g., both T = 0 and T = 1 pairing) is studied in detail. It is found that the two kinds of pairing are mutually exclusive and that the lowest HFB solution for the even–even N = Z nuclei has T = 0 independent pairs. The validity and the extent of these correlations is further examined by projecting the solutions onto eigenstates of the total number operator. These T = 0 pairing correlations occur for the axially symmetric prolate $^{24}$Mg, oblate $^{32}$S, and prolate $^{36}$Ar HFB solutions. In studying the relevance of these HFB solutions to the experimental spectra, it is found that the HFB field gives a more consistent description of the structure of N = Z even–even nuclei and that it can resolve the discrepancies and also the failures of the HF field in the upper half of the s-d shell. (auth)

**30948** STUDY OF THE $^{12}$C(p, p$\alpha$)$^{8}$Be REACTION AND EXCITED STATES OF $^{12}$C. Epstein, M. (Univ. of Maryland, College Park); Holmgren, H. D.; Jain, M.; Pugh, H. G.; Roos, P. G.; Wall, N. S.; Goodman, C. D.; Ludemann, C. A. Phys. Rev., 178: 1698-1705(Feb. 20, 1969).

The $^{12}$C(p, p$\alpha$)$^{8}$Be reaction was studied for several proton and $\alpha$-particle angles using a bombarding energy of 57 MeV. It is found that the reaction proceeds primarily by sequential $\alpha$ decay, i.e., the proton inelastically scatters, leaving $^{12}$C in an excited state which then decays by emitting an $\alpha$ particle. The properties of several of the excited states of $^{12}$C in the giant dipole region were investigated. States at 19.7, 21.1, 22.2, and 26 MeV were found which have a significant T = 0 component. In addition, the $^{12}$C(p, 2p)$^{11}$B reaction was measured simultaneously. These data indicate that a $^{12}$C state at 20.3 MeV decays to the ground state of $^{11}$B by proton emission. (auth)

**30949** QUASIFREE KNOCKOUT OF DEUTERONS IN THE $^{6}$Li($\alpha$, $\alpha$d)$^{4}$He REACTION AT 23.6 MeV. Baehr, K.; Becker, T.; Bilaniuk, O. M.; Jahr, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Rev., 178: 1706-8(Feb. 20, 1969).

$\alpha$-d correlations in quasi-elastic scattering of 23.6-MeV $\alpha$ particles on the deuteron cluster of the $^{6}$Li target were measured in and off the principal reaction plane. Despite the low cm energy of 14.2 MeV, the impulse approximation provides a reasonable description of the quasifree process. Computations were based on the asymptotic $\alpha$-d S-state wave function and on the cluster-model wave function of $^{6}$Li. Insensitivity of the fits to the details of the $^{6}$Li cluster-model wave function indicates an extreme surface reaction mechanism. The full width at half-maximum of the spectator momentum distribution was found to be 48 ± 6 MeV/c. By comparing the experimental cross section for the quasifree process at the maximum of the angular correlation ($d^2\sigma/d\Omega_d d\Omega$ = 68 ± 9 mb/sr$^2$ at $\theta$ = 25°, $\theta_d$ = 45°) with the corresponding cross section for the free process, the probability of finding $^{6}$Li as an $\alpha$-d cluster was evaluated. (auth)

**30950** RECOIL-DISTANCE METHOD FOR NUCLEAR LIFETIME MEASUREMENTS: STATES OF $^{22}$Na, $^{22}$Ne, AND $^{19}$F. Jones, K. W. (Brookhaven National Lab., Upton, N. Y.); Schwarzschild, A. Z.; Warburton, E. K.; Fossan, D. B. Phys. Rev., 178: 1773-82(Feb. 20, 1969).

The recoil-distance (or plunger) measurements of lifetimes of excited states produced in the bombardment of $^{19}$F by 5.5-MeV $\alpha$ particles is reported. A detailed discussion of small corrections involved in the analysis of these measurements is also presented. The corrections discussed are due to finite velocity spread of recoils, spread in distance between the target and plunger, effects of perturbation of $\gamma$-ray angular distributions, and various efficiency and solid-angle effects. The mean lives determined are as follows: $^{22*}$Na (0.891 MeV) : 14.4 ± 0.7 psec; $^{22*}$Na (1.528 MeV) : 5.0 ± 0.7 psec; $^{22*}$Na (2.211 MeV) : 20.8 ± 1.0 psec; $^{19*}$F (1.346 MeV) : 4.7 ± 0.6 psec; and $^{22*}$Ne (1.275 MeV) : 4.6 ± 0.5 psec. (auth)

**30951** FURTHER RESULTS ON $^{7}$He. Stokes, Richard H.; Young, P. G. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 178: 2024(Feb. 20, 1969).

Improved measurements of $^{3}$He spectra from the $^{7}$Li(t, $^{3}$He)$^{7}$He reaction have given final results for the $^{7}$He ground state. The $^{7}$He mass excess ($^{12}$C = 0) and width were determined, respectively, to

be 26.11 ± 0.03 and 0.16 ± 0.03 MeV. Measurements of differential cross section for the ground-state group are reported for center-of-mass angles of 11° to 63°, and for a triton bombarding energy of 22.0 MeV. (auth)

**30952** EVIDENCE FOR NUCLEON CLUSTERS IN THE LIGHTEST NUCLEI OF THE 1p-SHELL FROM DATA ON REACTIONS AT HIGH ENERGIES. Neudatchin, V. G.; Smirnov, Yu. F. (Moscow State Univ.). Progr. Nucl. Phys., 10: 273-305(1969).

Recent data on high-energy reactions on 1p-shell nuclei which support the nucleon cluster model are analyzed. The method for calculating electron inelastic form factors is described and applied to $^{6}$Li, $^{7}$Li, and $^{9}$Be. The structure of these nuclei is discussed. Some general features of nucleon cluster motion in light nuclei are described. (51 references) (J.W.R.)

**30953** THE APPLICATION OF A GAMMA-RAY CASCADE MODEL TO THE CALCULATION OF NEUTRON ENERGY-DEPENDENT CAPTURE GAMMA-RAY PRODUCTION CROSS SECTIONS. Yost, K. J. (Oak Ridge National Lab., Tenn.); Kremer, S. M. Nucl. Sci. Eng., 36: 220-31(May 1969).

A simplified cascade model for the calculation of neutron-capture gamma-ray spectra is compared with experiment. In the context of the model, the simplifying assumptions involve extrapolations of measured multipole transition probabilities and equal spin-branching probabilities. Calculated and measured neutron capture gamma-ray spectra are compared for 25 elements spanning virtually the entire mass scale. Substantial agreement between calculated and measured spectra is obtained for medium and heavy nuclei. An analytical method for obtaining neutron energy-dependent capture gamma-ray production cross sections is developed. A comparison between calculated and measured fast neutron capture gamma-ray yields in $^{64}$Cu is presented. (auth)

**30954** NUCLEAR SURFACE EFFECTS IN THE GIANT DIPOLE RESONANCES OF CLOSED-SHELL NUCLEI. Seaborn, J. B. (North Texas State Univ., Denton). Phys. Rev., 179: 958-61(Mar. 20, 1969).

The theory of collective correlations for giant resonances interacting with surface vibrations is extended to nuclei with closed-shell (nonvibrating) ground-state configurations. Electromagnetic transition matrix elements are calculated for dipole transitions in $^{16}$O and $^{40}$Ca. For both nuclei the results are in good agreement with experimental photonuclear cross-section measurements. (auth)

**30955** STUDY OF $\alpha$ + d AND $\alpha$ + d* SYSTEMS WITH THE RESONATING-GROUP METHOD. Thompson, D. R.; Tang, Y. C. (Univ. of Minnesota, Minneapolis). Phys. Rev., 179: 971-81 (Mar. 20, 1969).

The resonating-group method with a one-channel approximation is used to examine the $\alpha$ + d elastic scattering and bound-state problems. The nucleon-nucleon potential employed is the same as that used in previous resonating-group calculations and fits the low-energy scattering data satisfactorily. The deuteron wave function, which is given by a sum of two Gaussian functions, yields nearly correct values for the binding energy and the rms radius. For the bound and resonant states in $^{6}$Li, it is shown that a careful consideration of the distortion effect on the deuteron cluster is essential. The calculated excitation energy of the $^{3}$D level is 4.6 MeV, which is rather close to the value of 3.8 MeV obtained by averaging the excitation energies of the experimentally found $^{3}D_3$, $^{3}D_2$, and $^{3}D_1$ levels. Phase shifts are calculated in the energy region of 0 to 20 MeV and, in general, they agree quite well with those determined phenomenologically. In particular, the result shows that in the excitation region below 10 MeV, the P-wave phase shifts are small and show no resonance behavior. The T = 1 levels in the isobaric triad $^{6}$He, $^{6}$Li, and $^{6}$Be, which have predominantly a structure of an $\alpha$ cluster plus a two-nucleon cluster in a $^{1}S_0$ configuration (d* cluster), have also been studied. Here it is found that with a two-Gaussian function for the d* cluster, the calculated energy spacings between the $^{1}$S and the $^{1}$D levels are too large by about 1 MeV. (auth)

**30956** DOPPLER-SHIFT LIFETIME MEASUREMENTS IN THE p AND s-d SHELLS USING LITHIUM REACTIONS. Throop, M. J. (Univ. of Iowa, Iowa City). Phys. Rev., 179: 1011-33 (Mar. 20, 1969).

The Doppler-shift-attenuation method was used to deduce lifetime information for electromagnetic transitions in $^{10}$B, $^{11}$B, $^{12}$B, $^{13}$B, $^{11}$C, $^{14}$C, $^{14}$N, $^{15}$N, $^{16}$N, $^{17}$N, $^{16}$O, $^{18}$F, $^{20}$Ne, and $^{21}$Ne. The combination of a Ge(Li) $\gamma$-ray detector and the use of lithium reactions permitted an accurate measurement of numerous lifetimes as well as the setting of improved limits for very fast lifetimes. In addition, a number of transition energies were measured with improved accuracy. (auth)

**30957** BETA DECAYS OF $^{15}$C, $^{17}$F, AND $^{20}$F. Gallmann, A. (Institut de Recherches Nucleaires, Strasbourg); Jundt, F.; Aslanides, E.; Alburger, D. E. Phys. Rev., 179: 921-5(Mar. 20, 1969).

$\beta$-ray branches in the decays of $^{15}$C, $^{17}$F, and $^{20}$F were investigated by measuring the $\gamma$-ray spectra from these activities with a 22-cc Ge(Li) detector. The activities were formed by deuteron bombardment of various targets with a chopped Van de Graaff beam. Previously observed $^{15}$C $\beta$-ray branches to the 8312- and 9052-keV states of $^{15}$N were confirmed, the branches being [(5.0 ± 0.6) × $10^{-4}$; log ft = 5.06 ± 0.06] and [(3.5 ± 0.5) × $10^{-4}$; log ft = 3.99 ± 0.07], respectively, and one new branch was found leading to the 7300-keV state [(0.8 ± 0.2) × $10^{-4}$; log ft = 6.82 ± 0.13]. There is also weak evidence for a $\beta$-ray branch to the 8570-keV state of $^{15}$N[≤2.8 × $10^{-4}$; log ft ≥ 5.0]. The limit on the $\beta$ branching of $^{17}$R to the 871-keV state of $^{17}$O is <3.4 × $10^{-4}$, corresponding to log ft > 5.6. In $^{20}$F decay, lifetime measurements confirmed that a weak 3.3-MeV $\gamma$ ray is associated with this activity resulting from a $\beta$-ray branch to the 4.97-MeV state of $^{20}$Ne [(1.7 ± 0.3) × $10^{-4}$; log ft = 6.89 ± 0.08]. From simultaneous measurements on the $\gamma$ rays occurring in $^{20}$F and $^{12}$B decays, the energy of the $^{20}$F $\gamma$ ray is 3334.3 ± 0.7 keV, and thus the $^{20}$Ne level has an energy of 4968.3 ± 0.8 keV. (auth)

**30958** REACTION $^{12}$C($^{3}$He,d)$^{13}$N AND STRIPPING TO UNBOUND STATES. Fortune, H. T. (Florida State Univ., Tallahassee); Gray, T. J.; Trost, W.; Fletcher, N. R. Phys. Rev., 179: 1033-46(Mar. 20, 1969).

Excitation functions of deuterons from the $^{12}$C($^{3}$He,d)$^{13}$N reaction over the bombarding-energy range 12 to 19 MeV were measured at several angles for the ground-state deuterons and at a laboratory angle of 40° for deuterons leading to the ground state, to the first excited state, and to the unresolved second and third excited states. Detailed angular distributions were measured at 16, 17, and 18 MeV for the ground state through the third excited state and at 19 MeV for the ground state through the seventh excited state. The ground-state angular distributions were analyzed with the conventional distorted-wave Born approximation. For the excited states, all of which are unstable with respect to proton decay, a number of alternative methods of calculation were attempted and the results were compared. (auth)

**30959** LEVEL STRUCTURE IN $^{15}$O FROM THE PROTON BOMBARDMENT OF $^{14}$N. West, M. L.; Jones, C. M.; Bair, J. K.; Willard, H. B. (Oak Ridge National Lab., Tenn.). Phys. Rev., 179: 1047-59(Mar. 20, 1969).

Absolute cross sections for elastic scattering, $^{14}$N(p,p)$^{14}$N, and inelastic scattering, $^{14}$N(p,$p_1$)$^{14}$N*, from the first excited state were measured for proton bombarding energies between 3.7 and 5.67 MeV at laboratory angles of 67.5, 85.9, 105.8, 123.7, 135.0, and 157.5° in order to determine level parameters of excited states in $^{15}$O. Complete angular distributions were measured at selected energies in this region and limited angular distributions were obtained for inelastic scattering, $^{14}$N(p,$p_2$)$^{14}$N*, from the second excited state, and for the $^{14}$N(p,$\alpha$)$^{11}$C reaction. Scattering anomalies were observed at proton bombarding energies of 3.88, 3.90, 3.99, 4.13, 4.20, 4.575, 4.58, 4.63, 4.74, 4.78, 4.86, 5.02, 5.18, and 5.55 MeV, corresponding to excited states in $^{15}$O at 10.91, 10.93, 11.01, 11.14, 11.21. 11.56, 11.565, 11.61, 11.71, 11.75, 11.83, 11.97, 12.12, and 12.47 MeV. Resonances were analyzed using a multilevel R-matrix approximation. Qualitative and semiquantitative fits were made to these data and resonance parameters were determined for many of the observed levels. (auth)

**30960** SINGLET DEUTERONS (d) FROM (p,d) REACTIONS. Cohen, B. L.; May, E. C.; O'Keefe, T. M.; Fink, C. L. (Univ. of Pittsburgh). Phys. Rev., 179: 962-71(Mar. 20, 1969).

Singlet deuterons d (i.e., a neutron-proton system in the S = 0, T = 1 virtual state) are treated as particles emitted from nuclear reactions. A method for detecting them by n-p coincidence time-of-flight techniques is described. (p,d) reactions induced by 12-MeV protons on $^{7}$Li and $^{9}$Be, and by 17-MeV protons on $^{9}$Be, $^{13}$C, $^{25}$Mg, and $^{117}$Sn are investigated. In the lighter elements, angular distributions of d were measured and compared with those of deuterons from analogous (p,d) reactions, and the ratios R = $\sigma$(p,d)/$\sigma$(p,d) were determined. Semiquantitative comparisons with theory indicate reasonable agreement. In $^{25}$Mg and $^{117}$Sn, no (p,d) reactions could be detected, although they are expected to be observable at least in $^{117}$Sn. (auth)

**30961** AN EXPERIMENTAL STUDY OF INTERNAL BREMSSTRAHLUNG IN $\beta^+$ DECAY. Berenyi, D.; Scharbert, T.; Vatai, E. (Inst. of Nuclear Research, Debrecen, Hungary). pp 227-31 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25–28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.

See CONF-670981.

The internal bremsstrahlung accompanying the positron decay of $^{11}C$ was studied. The internal bremsstrahlung spectrum was measured in coincidence with the $\beta^+$ particles. A branching ratio of approximately $3.6 \times 10^{-3}$ IB quanta per day was determined. (J.W.R.)

**30962** MUON PARTIAL CAPTURE RATE MEASUREMENTS IN $^{6}Li$, $^{11}B$, AND $^{16}O$. Deutsch, J. P.; Grenacs, L.; Igo-Kemenes, P.; Lipnik, P.; Macq, P. C. (Univ., Louvain, Belg.). pp 259-61 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25–28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.
See CONF-670981.

The muon ($\mu^-$) capture rate for $^{6}Li$ was measured by the activation method. The result is compared with various theoretical predictions. (J.W.R.)

## Nuclear Properties and Reactions, $20 \leq A \leq 89$

*Refer also to abstracts 29212, 30920–30923, 30933–30938, 30943, 30947, 30950, 30953, 30954, 30956, 30957, 30996, and 31024.*

**30963** (BMwF-FBK-69-5) ANNUAL REPORT, 1967. (Technische Hochschule, Brunswick (West Germany). Institut A fuer Physik). Feb. 1969. 59p. (In German). Dep.

The Annual Report on Nuclear-Spectroscopic Investigations at the Institut A fuer Physik contains the following parts: Measurements with the Angular Correlation Apparatus; determination of E2/M1-mixing ratios of $2^+$-$2^+$-transitions in $^{186}Os$ and in $^{58}Fe$ and $^{74}Ge$ in the presence of positrons. Lifetime Measurements with a Parallel-Plate-Avalanche Counter using the Converter Technique: Study to extend the range of application of the detector to include measurements on gamma-transitions with low conversion coefficients. Investigation of fast Photomultipliers; systematic study of the time resolution as a function of different parameters for the photomultipliers XP 1021 and RCA 8575. Measurements with an ironfree Beta-Spectrometer; determination of shape factors and endpoint energies of beta-transitions in $^{60}Co$, $^{137}Cs$, $^{134}Cs$, $^{141}Ce$, and $^{170}Tm$. (auth)

**30964** (MIT-905-133, pp 1-36) NUCLEAR CHEMISTRY GROUP. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science).

Work on decay studies, fission studies, physics-chemical studies, earth science and activation analysis, and nuclear instrumentation performed during 1968 is reported. (J.W.R.)

**30965** (RPI-3947-2) NEUTRON AND GAMMA RAY EMISSION FROM HIGHLY EXCITED STATES AND STATES WITH HIGH SPIN. Annual Progress Report, June 1, 1968–May 31, 1969. Sperber, Daniel (Rensselaer Polytechnic Inst., Troy, N. Y.). Mar. 1969. Contract AT(30-1)-1955. 51p. Dep. CFSTI.

Work performed at Rensselaer Polytechnic Institute during the period June 1, 1968, to May 31, 1969, is reported. Methods were developed for the calculation of excitation functions and spectra in $(\alpha,xn)$, $(n,\gamma)$, and $(p,\gamma)$ reactions. Also methods were constructed for the evaluation of isomer ratios in (n,xn) reactions. Calculations were performed for these reactions on several nuclei using the compound nucleus statistical model. (J.W.R.)

**30966** RESONANCE-SCATTERING OF LIGHT FOR HYPERFINE STRUCTURE INVESTIGATIONS OF EXCITED STATES WITH SMALL SPLITTING COMPARED TO THE RADIATION WIDTH. MEASUREMENT OF THE NUCLEAR QUADRUPOLE MOMENTS OF $^{39}K$ AND $^{41}K$. Ney, J. (Technische Univ., Berlin). Z. Phys., 223: 126-38(1969). (In German).

In order to determine the nuclear quadrupole moments of the stable K isotopes, the hyperfine structure of the 4p and $5p^2P_{\frac{1}{2}}$-states was investigated by resonance scattering of light. The scattered intensity R(H) from separated isotopes in a sealed off resonance cell, as function of an external magnetic field H was observed with different polarisations ($\sigma$- and $\pi$-components perpendicular to H) both in exciting and scattered light. Because the hfs-splitting of the investigated states is comparable to the radiation width $\Gamma$, the measured change in intensity $\Delta R(H)/\Delta H$ is due to interference effects (Hanle-effect, level-crossing, anticrossing) and decoupling of electronic and nuclear spin (Heydenburg-effect). The different effects are not distinguishable in contrast to a usual level-crossing experiment and therefore the measured signal-structure is compared with line shape calculations according to Breit's-formula. Without Sternheimer corrections one obtains $Q(^{39}K) = 0.062 \cdot 10^{-24}$ cm$^2$ and $Q(^{41}K) = 0.076 \cdot 10^{-24}$ cm$^2$ for the electrical nuclear quadrupole moments of $^{39}K$ and $^{41}K$. (auth)

**30967** INVESTIGATION OF STATES IN $^{40}Ca$ BY THE $^{39}K$ (d,n) REACTION. Fuchs, H.; Grabisch, K.; Roeschert, G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys., A129: 545-70(1969).

Neutrons from the 6-MeV deuteron bombardment of $^{39}K$ were investigated by the time-of-flight method; 30 angular distributions of (d,n) transitions to states in $^{40}Ca$ up to an excitation energy of 10 MeV were obtained. They were analyzed with DWBA to yield l-values and spectroscopic factors. The l = 1 character of 14 transitions to states above 7.9 MeV determines their parity to be negative. From comparison with $^{39}K$(d,p) data, four levels above 9.4 MeV are proposed as possible analogues of $^{40}K$ states with dominant $d_{\frac{3}{2}}^{-1}p_{\frac{1}{2}}$ configuration. The experimental transition strengths are compared to previous ($\tau$,d) results and to predictions of the simple shell model. The main component of two shell-model particle-hole states is found in two other $^{40}Ca$ states than in previous investigations. At least 45% of the $d_{\frac{3}{2}}^{-1}p$ strength is moved away from the zero-order particle-hole states of the shell model. Theoretical spectroscopic factors were derived from the wave functions of Gerace and Green obtained by mixing spherical 1p-1h states with deformed 3p-3h states. Near to quantitative agreement with experiment is observed. (auth)

**30968** SINGLE-PARTICLE HOLE AND COLLECTIVE LEVELS OF $^{40}Ca$ AND $^{60}Ni$. Ballini, R.; Delove, Zh.; Fuan, Zh. P.; Blair, A. G.; Tsindro, N. (Central Nuclear Inst., Saclay, France. Zagreb Inst.). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 1653-7(1968). (In Russian).

The collective levels of the closed proton shell nuclei $^{40}Ca$ and $^{60}Ni$ were studied by proton scattering ($E_p$ = 13 MeV) and proton transfer reactions $^{39}K(^3He,d)$ and $^{59}Co(^3He,d)$ ($E_{^3He}$ = 18 and 12 MeV). Studies of the above nuclei within the limits of a simple shell model with particle–hole interactions offered good results up to comparatively high excitation levels, especially in the case of $^{60}Ni$. It was assumed that a great number of excitation levels, at the energies studied, are the result of complex configurations related to many particles and many holes. (R.V.J.)

**30969** ACCOUNT OF THE MAIN NUCLEAR-STRUCTURE PROPERTIES IN THE OPTICAL POTENTIAL FOR NEUTRON ELASTIC SCATTERING. Dotsenko, B. B. (Univ. of Alberta, Edmonton). Phys. Rev., 178: 1647-54(Feb. 20, 1969).

An attempt is made to establish the correspondence between the nonlocal optical potential and simple structural properties of nuclei. The presentation of the potential as a superposition of separable partial potentials permits one to solve the Schrödinger equation analytically rather than numerically, as is usually done. Additional conditions establish an evident correspondence between the potential and the simple Fermi-gas model of nuclei. It allows one to keep some potential parameters fixed, so that the number of actually variable parameters is usually less than that for a local potential. A simple expression for the S-matrix elements is found, using the asymptotic properties of the partial equation and its solution. For calculation of the cross section the computation of only ten relatively simple integrals was necessary, instead of the numerical solution of a complicated integrodifferential equation. The neutron elastic-scattering cross sections were calculated for this model for Pb, Ca, and Fe nuclei. The main conclusions are as follows: The scattering and absorption of neutrons are connected with the outer part of the potential, corresponding to the outer layer of the nucleus and to the density fluctuations in this layer. The inner part of the potential influences the above processes only slightly and might be described as corresponding to the "inert core" of the nucleus. (auth)

**30970** STRUCTURE OF SOME SIMPLE SHELL-MODEL WAVE FUNCTIONS. Bhatt, K. H. (Oak Ridge National Lab., Tenn.); Ball, J. B.; Parikh, J. C. Phys. Rev., 178: 1632-46 (Feb. 20, 1969).

The wave functions for the lowest-energy states with different angular momenta of the nuclei $^{39,40}Ar$, $^{41}K$, $^{51}Ti$, $^{93,95}Nb$, and $^{95,96,97}Mo$ resulting from simple shell-model calculations are compared with the wave functions with definite angular momenta projected from (deformed) determinantal intrinsic states for these nuclei. Significant resemblance between the two is found. An attempt is made to give some insight into the general features which emerge from the comparison of the two sets of wave functions. (auth)

**30971** SCATTERING OF MEDIUM-ENERGY ALPHA PARTICLES. II. MICROSCOPIC ANALYSIS OF ELASTIC SCATTERING. Jackson, Daphne F.; Kembhavi, V. K. (Univ. of Surrey, Guildford, Eng.). Phys. Rev., 178: 1626-31(Feb. 20, 1969).

A microscopic description of the elastic scattering of medium-energy $\alpha$ particles is given in terms of an optical potential calculated from the nuclear-matter distribution and an effective $\alpha$-

nucleon interaction. It is shown that the differential cross section is very sensitive to changes in the range parameter of the effective interaction, and that this sensitivity is reflected in the magnitude predicted for the strong-absorption radius. It is also shown that this microscopic analysis can lead to an A dependence for the strong-absorption radius of 1.5 $A^{\frac{1}{3}}$, in accordance with the general trend observed in optical-model and direct phase analyses, although the fits to the data are not yet sufficiently accurate to yield very precise results for the strong-absorption radii of individual nuclei. (auth)

**30972** SHAPES AND SYMMETRIES OF LIGHT NUCLEI. Banerjee, M. K.; Levinson, C. A.; Stephenson, G. J. Jr. (Univ. of Maryland, College Park). Phys. Rev., 178: 1709-14(Feb. 20, 1969).

It is demonstrated that the existence of symmetries under the operations T, P $\exp(-i\pi J_y)$, and $\exp(i\pi J_z)$ in the Hartree–Fock densities of even-even N = Z nuclei follows directly from two indisputable features of any effective shell-model interaction, viz., the general exchange nature and the short range. It is shown that this implies that one should not expect parity mixing in Hartree–Fock ground state wave functions for these nuclei. Finally, it is demonstrated that these same features of the interaction allow one to predict the shapes of the Hartree–Fock densities. (auth)

**30973** CLUSTER-MODEL THEORY OF THE GROUND-STATE ROTATIONAL BAND OF $^{20}$Ne. Chang, F. C. (St. John's Univ., Jamaica, N. Y.). Phys. Rev., 178: 1725-7(Feb. 20, 1969).

The excitation energies of the ground-state rotational band as well as the reduced transition rate for the transition from the first excited state to the ground state in $^{20}$Ne were calculated with the use of cluster wave functions. The agreement between the calculated and observed values suggests that the properties of the ground-state rotational band in $^{20}$Ne can also be explained in terms of cluster motion. (auth)

**30974** EXCITED STATES OF $^{88}$Y STUDIED BY THE $^{88}$Sr (p,n)$^{88}$Y REACTION. Dutt, G. C.; Gabbard, F. (Univ. of Kentucky, Lexington). Phys. Rev., 178: 1770-2(Feb. 20, 1969).

Excitation functions and angular distributions were measured for two neutron groups in the $^{88}$Sr(p,n)$^{88}$Y reaction, leaving $^{88}$Y in the excited states at 706 and 773 keV, respectively. The spins and parities of these two states were deduced from comparison with computations based on the statistical theory of nuclear reactions. (auth)

**30975** NEUTRON RADIATIVE CAPTURE IN Na, Al, Fe, AND Ni FROM 1 TO 200 keV. Hockenbury, R. W.; Bartolome, Z. M.; Tatarczuk, J. R.; Moyer, W. R.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 178: 1746-69 (Feb. 20, 1969).

Neutron radiative capture in Na, Al, Fe, and Ni was measured from 100 eV to 200 keV with a 1.25-m-diam liquid scintillator detector at the Rensselaer LINAC Laboratory. Radiation widths were determined for those resonances whose neutron widths are well known, while the resonance capture areas ($\sigma_0\Gamma_\gamma$) were determined for most of the other resonances. Considerably more resonances were observed in the capture measurements upon Fe and Ni than had been observed in total cross-section measurements. It is reasonable to assign most if not all of these previously undetected resonances to p-wave neutrons, and from these data p-wave strength functions of $(0.10 \pm 0.04) \times 10^{-4}$ and $(0.04 \pm 0.03) \times 10^{-4}$ were determined, respectively, for $^{56}$Fe and $^{58}$Ni. These strength functions are probably just upper limits to be true p-wave strength functions and are an order of magnitude smaller than optical-model predictions. (auth)

**30976** POPULATION OF THE 2.37-MeV 0+ LEVEL IN $^{66}$Zn BY $^{66}$Cu. Carter, H. K. (Vanderbilt Univ., Nashville); Hamilton, J. H.; Pinajian, J. J. Phys. Rev., 178: 1743-5(Feb. 20, 1969).

The decay of $^{66}$Cu to $^{66}$Zn was studied with Ge(Li) detectors. The following $\gamma$ rays were observed (energies in keV and intensities in parentheses): 833.0 ± 1.0 (1.7 ± 0.4), 1039.2 ± 0.2 (100), and 1332.5 ± 1.5 (0.032 ± 0.006). These depopulate the following levels in $^{66}$Zn: 1039.2 ± 0.2, 2+; 1872.2 ± 1.0, 2+; and 2371.7 ± 1.5, 0+. The spin of the 2372-keV level was determined to be zero by $\gamma$-$\gamma$ directional correlation studies of the 1039.2–1332.5-keV cascade. The $A_2$ and $A_4$ values obtained are 0.49 ± 0.32 and 1.16 ± 0.44, respectively. (auth)

**30977** STUDY OF (p,xn) REACTIONS AT 400 MeV. Church, Larry B.; Caretto, Albert A. Jr. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., 178: 1732-42(Feb. 20, 1969).

Cross sections for a number of (p,xn) reactions ($1 \leq x \leq 4$) at 400 MeV are reported. The excitation function for the $^{72}$Ge (p,xn)$^{72-x}$As system was measured between 100 and 400 MeV. The data are compared with the results of Monte Carlo cascade (Vegas) calculations and evaporation calculations. The experimental dependence of the $^{75}$As(p,xn)$^{76-x}$Se cross sections on x did not agree well with the results of these calculations, although the Vegas step calculations reproduced the shape of this dependence. The cross-section data are consistent with a mechanism involving charge-exchange p-n scatterings, within the target nucleus, followed by the evaporation of x – 1 neutrons. The ratio of $\sigma$(p,2n) to $\sigma$(p,n) was found to be approximately linear with the quantity $E^*_{T_<}/S_n$. This quantity is the ratio of the excitation energy obtained if the isobaric analog state of the target is populated via the (p,n) reaction, to the neutron separation energy. On the basis of the postulated mechanism, the probability for charge-exchange scattering as a function of excitation energy was obtained for $^{89}$Y and $^{126}$Te. (auth)

**30978** MAGNETIC MOMENT OF THE FIRST EXCITED STATE IN $^{83}$Kr BY THE MOESSBAUER EFFECT. Campbell, L. E. (Argonne National Lab., Ill.); Perlow, G. J.; Grace, M. A. Phys. Rev., 178: 1728-31(Feb. 20, 1969).

The magnetic moment of the 9.3-keV first excited state in $^{83}$Kr was measured by use of the Moessbauer effect. Source and absorber were solid krypton at 4.2°K with the absorber in a longitudinal magnetic field of 77.8 kOe from a superconducting solenoid. The ratio R of the g factor of the $\frac{7}{2}^+$ excited state to that of the $\frac{9}{2}^+$ ground state was found to be +1.249 ± 0.002, from which $\mu(\frac{7}{2}^+) = -(0.939 \pm 0.002)\mu_N$ without diamagnetic correction. If the ground state could be considered a pure configuration of three $g_{\frac{9}{2}}$ neutron holes coupling to $J = \frac{9}{2}$ and the excited state a recoupling within the same configuration, then R = 1. Furthermore, the M1 transition matrix element would vanish. The transition is indeed retarded. It appears from the work of Noya, Arima, and Horie that a modest admixture into each state of the configuration obtained by promoting one $g_{\frac{9}{2}}$ neutron to $g_{\frac{7}{2}}$ can in the main account for both the observed transition rate and the excess in R. (auth)

**30979** MAGNETIC MOMENT OF THE 9.3-keV NUCLEAR LEVEL OF $^{83}$Kr. Greenshpan, M. (Weizmann Inst. of Science, Rehovot, Israel); Treves, D.; Bukshpan, S.; Sonnino, T. Phys. Rev., 178: 1802-3(Feb. 20, 1969).

The magnetic moment of the 9.3-keV nuclear level of $^{83}$Kr was obtained by measuring the Zeeman splitting of the Moessbauer lines in an external magnetic field. Experiments with a Kr clathrate source and absorber in a longitudinal field and a ZnSe source with a solid Kr absorber in a transverse field yielded a magnetic moment of $(-0.99 \pm 0.08)\mu_N$. (auth)

**30980** EXCITATION FUNCTION FOR THE $^{25}$Mg(p,2p)$^{24}$Na REACTION IN THE GeV ENERGY REGION. Reeder, Paul L. (Washington Univ., St. Louis. Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 178: 1795-1801(Feb. 20, 1969).

The cross section for the $^{25}$Mg(p,2p)$^{24}$Na reaction was measured at 8 energies from 0.43 to 2.7 GeV. The cross sections increased from 26.7 ± 0.8 mb at 0.43 GeV to 31.9 ± 1.0 mb at 1.01 GeV. As expected from the clean-knockout mechanism, this increase is related to a large increase in free-particle cross section. An empirical expression which takes into account the momentum of the struck particle and a rough estimate of attenuation factors gives a reasonable fit to all cross-section data from 0.15 to 2.7 GeV. Monte Carlo calculations at 0.15 GeV also agree with the experimental cross sections. Effective forward and backward ranges for $^{24}$Na in $^{25}$Mg were measured, using the thick-target-thick-catcher technique. (auth)

**30981** $^{18}$N AND $^{22}$F GROUND STATES, $^{22}$F EXCITED STATES, AND T = 2 ANALOGS IN $^{22}$Ne. Stokes, Richard H.; Young, P. G. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 178: 1789-94 (Feb. 20, 1969).

Energy spectra of $^3$He ions from the $^{16}$O(t,$^3$He)$^{18}$N and the $^{22}$Ne (t,$^3$He)$^{22}$F reactions were measured for a triton bombarding energy of 22 MeV. A proportional ΔE detector and a silicon E detector were used to identify and measure the energy of the $^3$He ions. From Q-value determinations, ground-state mass excesses ($^{12}$C = 0) were found to be 13.274 ± 0.030 MeV for $^{18}$N and 2.828 ± 0.030 MeV for $^{22}$F. The $^{22}$F mass value is 1.67 MeV lower than the only previously reported value. Other groups in the spectra correspond to the first observation of excited states in $^{22}$F. Excitation-energy values for these six excited states are 0.66, 1.36, 1.57, 1.97, 2.54, and 2.91 MeV. Also, spectra from the (p,p'), (d,d'), and (t,t') reactions were measured with a $^{22}$Ne target to search for T = 2 analogs to $^{22}$F states. Groups which appeared only in the $^{22}$Ne(p,p') and $^{22}$Ne (t,t') spectra have Coulomb-energy shifts and widths which suggest that they are analogs to the ground, second, third, and fourth excited states of $^{22}$F. Based on the measured values of the $^{18}$N and $^{22}$F ground-state masses and the systematics of pairing energy,

estimates are made for the masses of the unreported nuclei $^{22}$Al, $^{19}$N, $^{21}$O, and $^{23}$F. The last three nuclei are predicted to be stable against neutron decay, whereas $^{22}$Al is estimated to be near the limit of proton stability. (auth)

**30982** $1d_{\frac{3}{2}} - 1f_{\frac{7}{2}}$ ENERGY SPLITTING AT $^{40}$Ca. Hubbard, L. B. (Argonne National Lab., Ill. Massachusetts Inst. of Tech., Cambridge); Jolly, H. P. Phys. Rev., 178: 1783-8(Feb. 20, 1969).

The low-lying levels of nuclei near closed shells are commonly assumed to be of pure, single-particle model configurations. On this basis the single-particle and single-hole energies used in shell-model calculations are taken from the experimental energy spectra of these nuclei. In recent years, however, both direct-reaction experiments and theoretical calculations have shown that there is considerable configuration mixing in the $^{40}$Ca ground-state wave function, asscciated with a depression in the ground-state energy. Since the underlying approximation is not valid, the use of experimental energy differences as the single-particle energies in shell-model calculations is not justified. From calculations of the effects of mixing on the A = 39 and A = 41 nuclei, as well as on $^{40}$Ca, it is found that the conventional experimental splittings overestimate the important $1d_{\frac{3}{2}} - 1f_{\frac{7}{2}}$ energy difference by at least 1 MeV. A smaller error is contained in the "experimental" $2s_{\frac{1}{2}} - 1f_{\frac{7}{2}}$ splitting. Similar effects occur in the oxygen region, but the overestimation in the $1p_{\frac{1}{2}} - 1d_{\frac{5}{2}}$ splitting is much smaller, since the mixing is considerably less. (auth)

**30983** DIRECT MEASUREMENT OF THE K ELECTRON CAPTURE TO POSITRON EMISSION RATIO IN THE DECAY OF $^{22}$Na. McCann, M. F.; Smith, K. M. (Univ. of Glasgow). J. Phys., A (London), 2: 392-7(May 1969).

The 0.87 keV K electron-capture peak of $^{22}$Na was observed using an internal source and the scintillation counter technique. Direct measurement of the $K/\beta^+$ ratio was therefore possible: the result obtained was $K/\beta^+ = 0.105 \pm 0.009$. A review is also given of recent precise results of the total capture to positron ratio ($e/\beta^+$) in $^{22}$Na, and the interpretation of these experiments is discussed. It is shown that the correction for electron exchange and overlap effects to the $K/\beta^+$ ratio has a smaller effect than has been supposed for low atomic numbers, and that it is impossible to deduce an estimate for the Fierz interference term b from $K/\beta^+$ or $e/\beta^+$ measurements on light isotopes. (auth) (UK)

**30984** DECAY STUDY OF $^{75}$Br. Ladenbauer-Bellis, Inge-Maria; Bakhru, H. (Yale Univ., New Haven). Phys. Rev., 178: 2019-23(Feb. 20, 1969).

The radioactive decay of bromine-75 was studied with a 16-cc Ge(Li) detector and a standard scintillation spectrometer. The bromine isotope was produced with carbon-12 ions (3.9 MeV/nucleon) on natural copper targets. The following $\gamma$ rays, decaying with a half-life of 95.5 ± 1.5 min, were found: 110 ± 1, 140 ± 1, 286 ± 1, 378 ± 1, 426 ± 1, 430 ± 1, 569 ± 1, 606 ± 1, 654 ± 1, 728 ± 1, 788 ± 1, 900 ± 1, 940 ± 1, 948 ± 1, and 1233 ± 2 keV. Coincidence measurements were performed, and a tentative decay scheme for bromine-75 is given. (auth)

**30985** ENERGY LEVELS IN $^{47\ 49\ 51}$V AND $^{51\ 53\ 55}$Mn FROM ($^3$He,d) REACTIONS. Cujec, B.; Szoeghy, I. M. (Laval Univ., Quebec). Phys. Rev., 179: 1060-82(Mar. 20, 1969).

The $^{46,48,50}$Ti($^3$He,d)$^{47,49,51}$V and $^{50,52,54}$Cr($^3$He,d)$^{51,53,55}$Mn reactions were studied with high resolution at 10- and 9.5-MeV incident energies, respectively. The l values and spectroscopic factors were extracted by means of the distorted-wave Born-approximation calculations. A systematic study of the $p_{\frac{3}{2}}$ centroid energies, of the $d_{\frac{5}{2}}$ and $s_{\frac{1}{2}}$ proton hole states, and of the splitting of the $p_{\frac{3}{2}}$ spectroscopic strength is presented. These quantities, and also the individual energy spectra, are compared with the expectations of the shell model and the Coriolis strong-coupling model. It is concluded that the shell model adequately describes these nuclei, while the Coriolis strong-coupling model fails to explain the observed splitting of the $p_{\frac{3}{2}}$ spectroscopic strength. (auth)

**30986** $j_n$ DEPENDENCE OF (d,p) REACTIONS FROM THE WEAKLY BOUND PROJECTILE MODEL. Pearson, C. A. (Univ. of Arizona, Tucson); Bang, J. M.; Pocs, L. Phys. Rev., 179: 1082-9(Mar. 20, 1969).

The $j_n$ dependence of the angular distributions for certain (d,p) reactions is calculated from the weakly bound projectile (WBP) model of Pearson and Coz. Agreement is found with the observed $j_n$ dependence. It is suggested that the model can be used for extracting the value of $j_n$ from accurately measured angular distributions. (auth)

**30987** LEVELS OF $^{68}$Ga AND $^{71}$Ga VIA THE (n,n'$\gamma$) REACTIONS. Velkley, D. E.; Chung, K. C.; Mittler, A.; Brandenberger, J. D.; McEllistrem, M. T. (Univ. of Kentucky, Lexington). Phys. Rev., 179: 1090-9(Mar. 20, 1969).

Differential cross sections for the production of $\gamma$ rays in the Ga(n,n'$\gamma$) reactions were measured at 90° as a function of incident energy for $0.4 \leq E_n \leq 2.5$ MeV. Angular distributions at $E_n = 0.650$, 0.800, 1.50, and 1.78 MeV were also measured. Level schemes and decay schemes including branching ratios were determined. An earlier scheme for $^{69}$Ga is confirmed, and two new levels are found. The level scheme of $^{71}$Ga is defined for excitation energies below 2 MeV. From the $\gamma$-ray angular distributions and neutron inelastic scattering cross sections, spins were determined for five levels in each isotope. When these and other measurements are combined, the following excitation energies in keV, spins, and parities result. In $^{69}$Ga: 319($\frac{1}{2}^-$), 573($\frac{5}{2}^-$), 873($\frac{3}{2}^-$), 1027, 1108($\leq\frac{5}{2}$), 1334($\frac{7}{2}$), 1527, 1724, and 1893. In $^{71}$Ga: 390($\frac{1}{2}^-$), 487($\frac{5}{2}^-$), 512($\frac{3}{2}^-$), 911($\frac{1}{2}^-$,$\frac{3}{2}^-$), 965($\frac{7}{2}$), 1108($\frac{7}{2}^-$), 1474, 1487, 1495($\frac{9}{2}^+$), 1700, and 1750. (auth)

**30988** THEORETICAL DESCRIPTION OF ENERGY LEVELS OF $^{59}$Fe. Sood, P. C. (Univ. of Alberta, Edmonton). Phys. Rev., 179: 1100-4(Mar. 20, 1969).

The energy levels of the nucleus $^{59}$Fe are described in terms of the single-particle Nilsson model. The known negative-parity levels are fitted into three rotational bands, and the location of other levels is predicted on the basis of a determination of the nuclear potential parameters. The spectroscopic factors for levels in the ground-state band are compared with the calculated values. Further checks of the model are proposed. (auth)

**30989** EXCITATION FUNCTIONS FOR RADIOACTIVE NUCLIDES PRODUCED BY DEUTERON-INDUCED REACTIONS IN IRON. Clark, J. W.; Fulmer, C. B.; Williams, I. R. (Oak Ridge National Lab., Tenn.). Phys. Rev., 179: 1104-8(Mar. 20, 1969).

Cross sections were measured for the production of radioactive nuclides by deuteron-induced reactions in natural iron at bombarding energies below 40 MeV. Deuteron beams of the Oak Ridge isochronous cyclotron were used to bombard stacked iron foils. $\gamma$ spectra of individual foils were measured with a Ge(Li) spectrometer. Radioactivities with half-lives greater than 20 min were measured. Excitation functions were obtained for $^{55}$Co, $^{56}$Co, $^{57}$Co, $^{58}$Co, $^{52}$Mn, $^{54}$Mn, $^{54m}$Mn, and $^{51}$Cr. Cross sections predicted by a compound-nucleus evaporation theory are in reasonable agreement with the experimental results. (auth)

**30990** ANALYSIS OF FRAGMENTED ANALOG-STATE RESONANCES BY COUPLED OPTICAL EQUATIONS WITH EFFECTIVE NONLOCAL POTENTIALS. Bartels, E. C.; Cosman, E. R.; Kerman, A. K.; Spencer, J. E. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 179: 995-1001(Mar. 20, 1969).

The fragmentation of single-particle analog resonances in proton elastic scattering is accomplished here by means of an effective nonlocal optical potential added to the Lane equations This potential is inferred from the analogous potential in the parent isobaric nucleus, where it arises from the coupling of the single-neutron states to other degrees of freedom in that system. The new coupled equations are solved numerically by an iterative procedure for the case of $^{88}$Sr + p using an average set of optical-model parameters and the known (d,p) spectroscopic factors. The elastic excitation functions calculated in this way compare closely to experiment over a range of energies of $E_p = 4.8$ to 8.1 MeV, which includes six $2d_{\frac{5}{2}}$, $2d_{\frac{3}{2}}$, $3s_{\frac{1}{2}}$, and $1g_{\frac{9}{2}}$ resonances. The sensitivity of the calculations to the various input parameters indicates that the method may be useful for providing independent determinations of both optical-model parameters and spectroscopic factors. Some shortcomings of the model are discussed and future improvements indicated. (auth)

**30991** SYMPOSIUM ON NUCLEAR BETA DECAY AND WEAK INTERACTIONS, ZAGREB, YUGOSLAVIA, SEPTEMBER 25–28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967. 322p. (CONF-670981).

Separate abstracts were prepared for the 20 papers included. (J.W.R.)

*For abstracts of individual papers see: 30351, 30932, 30961, 30962, 30992–30994, 31046–31051, and 31091–31097.*

**30992** THE POSITRON SPECTRUM OF $^{22}$Na AND THE NEUTRINO REST MASS. Beck, E.; Daniel, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 269-75 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25–28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.

See CONF-670981.

The positron spectrum of $^{22}$Na was measured and used to set limits on the neutrino rest mass. Implications to the degenerate neutrino gas cosmological model were drawn. (J.W.R.)

**30993** ENERGY DEPENDENCE OF $\beta$–(CIRCULARLY POLARIZED $\gamma$) CORRELATIONS. Daniel, H.; Mehling, O. (Max-

Planck-Institut fuer Kernphysik, Heidelberg). pp 277-84 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25–28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.

See CONF-670981.

Apparati were constructed for measuring $\beta-\gamma$ (circularly polarized) correlations simultaneously as functions of energy and angle. Measurements were performed for the beta decays of $^{60}$Co and $^{86}$Rb and the positron decay of $^{22}$Na. (J.W.R.)

**30994** MEASUREMENT OF THE $\beta-\gamma$ CIRCULAR POLARIZATION CORRELATION IN THE DECAY OF $^{48}$Sc, $^{65}$Ni, AND $^{152}$Eu. Behrens, H.; Wischhusen, R. (Univ., Karlsruhe, Ger. Kernforschungzentrum, Karlsruhe, Ger.). pp 247-52 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25–28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.

See CONF-670981.

Measurements were performed of the $\beta-\gamma$ circular polarization correlations in the decay of $^{48}$Sc, $^{65}$Ni, and $^{152}$Eu. Asymmetry coefficients were determined and the isospin-forbidden Fermi matrix elements were derived. (J.W.R.)

# Nuclear Properties and Reactions, A ≥ 90

*Refer also to abstracts 29186, 29212, 30631, 30920, 30921, 30923, 30933, 30934, 30953, 30963, 30964, 30969, 30970, 30977, 30991, 30994, 31069, 31071, 31073, 31074, and 31223.*

**30995** (AERE-M-2157) AVERAGE FISSION CROSS SECTIONS AND RESONANCE INTEGRAL CONTRIBUTIONS BETWEEN 10 eV AND 20 keV DEDUCED FROM SCISRS DATA TAPES. James, G. D.; Schomberg, M. G. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1969. 12p. Dep. CFSTI. UK 2s. 6d.

Data tapes listing the experimental fission cross section data for $^{233}$U, $^{235}$U, $^{239}$Pu, and $^{241}$Pu below 35 keV from the SCISRS data file were obtained and used to determine the average fission cross section and resonance integral contribution over selected energy ranges from 10 eV to 20 keV. These results are presented in tabular form. It is noted that three of the data sets are discrepant. (auth)

**30996** (BMwF-FBK-68-39) ANNUAL REPORT, 1967. (Technische Hochschule, Munich (West Germany). Teilinstitut Maier-Leibnitz im Physikdepartment). Aug. 1968. 170p. (In German). Dep.

Results of the following experiments are reported: Coherent scattering length and free cross-section for slow neutrons, (n,$\gamma$) and (n,e$^-$) spectra, (n,p), (n,$\alpha$) and (n,2n) cross-sections, light emission after $\beta$-decay, nuclear resonance-fluorescence yields in solids, fatigue measurements in copper and steel, irradiation induced changes of electrical, mechanical and magnetic properties of metals at low temperatures, and small angle scattering of neutrons and X-rays. In addition we report on the construction of a time-of-flight neutron spectrometer and neutron guide tubes for production of polarized and extremely slow neutrons. (auth)

**30997** (GA-9275) NEUTRON CROSS-SECTION MEASUREMENTS. Summary Report, March 1, 1968–February 28, 1969. Fricke, M. P.; Lopez, W. M.; Costello, D. J.; Friesenhahn, S. J.; Carlson, A. D. (Gulf General Atomic, Inc., San Diego, Calif.). Mar. 27, 1969. Contract AT(04-3)-167. 67p. Dep. CFSTI. Includes Appendix.

Work performed on neutron cross sections at Gulf General Atomic from March 1, 1968 to Feb. 28, 1969 is described. The work included gadolinium and zirconium resonance parameters, gadolinium and gold capture cross sections, and the $^3$He(n,p)T reaction cross section. General experimental improvements and work planned for the future are also described. (J.W.R.)

**30998** (RPI-328-148, pp 1-17) NEUTRON CROSS SECTIONS. (Rensselaer Polytechnic Inst., Troy, N. Y.).

Progress in the determination of neutron cross sections in the period October 1, 1968, to December 31, 1968, is summarized. The studies include capture and transmission measurements in Hf, W, and Zr isotopes, neutron resonances in $^{148}$Pm and $^{239}$Pu, total cross sections for Hf isotopes, and the testing of a prototype MeV neutron detector. (J.W.R.)

**30999** THE EC-DECAY OF $^{170}$Tm. Hansen, H. H.; Hellstroem, S. (EURATOM, Geel, Belgium). Z. Phys., 223: 139-44(1969).

The spectrum of K x rays and $\gamma$ rays following the decay of $^{170}$Tm was reinvestigated using a high-resolution Si(Li) detector. The intensities of the EC branches from the ground state of $^{170}$Tm to the ground state as well as to the first excited level in $^{170}$Er were measured. The total intensity of EC decay is (0.25 ± 0.05)% of all $^{170}$Tm disintegrations with (0.18 ± 0.05)% leading to the ground state and (0.07 ± 0.02)% leading to the first excited level of $^{170}$Er. The energy of the de-exciting $\gamma$ ray was determined to (78.7 ± 0.5) keV. Its intensity is (0.28 ± 0.06)% of that of the 84.3 keV $\gamma$ ray in $^{170}$Yb. (auth)

**31000** $^{169}$Yb LEVELS EXCITED IN THE (n,$\gamma$) REACTION. Bondarenko, V. A.; Prokof'ev, P. T.; Manfrass, P.; Andreeff, A. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 1, 3-16(1969). (In Russian).

Excited states of $^{169}$Yb from thermal neutron capture were investigated. Conversion electrons were studied by means of a $\beta$ spectrograph, whereas a Ge(Li) detector was used for a $\gamma$-ray study. The proposed $^{169}$Yb scheme was found to contain rotational bands based on the following levels: $^7/_2$[633] (0 keV), $^1/_2^-$[521] (24.2 keV), $^5/_2^-$[512] (191.4 keV), $^5/_2^-$[523] (569.9 keV), $^7/_2^+$[642] (590.3 keV), $^9/_2^-$[521] (659.6 keV), $^1/_2^+$[651] (719.8 keV), $^1/_2^-$[510] + $\gamma$ = vibr. (813.4 keV). Additionally 1270.1, 1354.0, 1398.5, 1802.6, 1934.4, and 2243 keV levels were also observed. (auth)

**31001** ALPHA DECAY OF THE THERMAL NEUTRON CAPTURE STATE OF $^{156}$Gd. Beg, K.; Macfarlane, R. D. (McMaster Univ., Hamilton, Can.). Nucl. Phys., A129: 571-6(1969).

Alpha-particle emission from the thermal neutron capture state of $^{156}$Gd was detected for the first time. Two groups were observed corresponding to transitions to the first and second excited state of $^{152}$Sm. No ground state transitions were observed which confirms the 2$^-$ spin and parity assignment for the capture state. The total effective (n,$\alpha$) cross section was measured to be 82 ± 7 $\mu$b. The relevance of these results to the determination of the Porter–Thomas distribution of $\alpha$-decay widths and correlations between $\alpha$-decay exit channels is discussed. (auth)

**31002** PARTICLE-CORE STATES IN $^{207}$Pb. Mukherjee, P.; Rao, K. V. Chalapati; Mukherjee, I. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys., A129: 535-44(1969).

The highly excited positive parity states (2.7 MeV to 6 MeV) in $^{207}$Pb are examined in terms of a simple phenomenological core-particle model. All the six known positive parity states ($g_{9/2}$, $i_{11/2}$, $d_{3/2}$, $s_{1/2}$, $d_{5/2}$, and $g_{7/2}$) in the N = 126 to 184 shell are assumed to couple with the quadrupole phonon vibration of the $^{208}$Pb core. For the $^9/_2^+$ and $^9/_2^+$ states three cases corresponding to one-, two-, and three-phonon coupling are examined separately, while for the rest of the spin-states only one- and two-phonon cases are considered. The single-particle reduced widths are found to be very sensitive to the particle-core coupling strength, x. To reproduce the observed $^{206}$Pb(d,p) data two-phonon coupling with x = 0.30 seems to be the most satisfactory scheme. Both one-phonon and three-phonon coupling fail to reproduce the correct single-neutron reduced widths of the various $^5/_2^+$ and $^9/_2^+$ states observed in the (d,p) reaction. The gross-structure of the isobaric analog resonance for the $^{206}$Pb(p,p′) reactions leading to the first 2$^+$ state in $^{206}$Pb is found to change considerably if one uses the two-phonon coupling scheme rather than the one-phonon scheme. Instead of the 17 states predicted to be excited in the resonance spectra from the one-phonon model, altogether 31 states are shown to have measurable inelastic widths in the two-phonon scheme. (auth)

**31003** COULOMB EXCITATION OF THE EVEN-A CADMIUM NUCLEI. Milner, W. T.; McGowan, F. K.; Stelson, P. H.; Robinson, R. L.; Sayer, R. O. (Oak Ridge National Lab., Tenn.). Nucl. Phys., A129: 687-96(1969).

Coulomb excitation of the first 2$^+$ states of the even-A cadmium nuclei was produced by 2.7 and 3.0 MeV protons to obtain accurate B(E2, 0 → 2) values (absolute error ±4%). The B(E2, 0 → 2) obtained for $^{114}$Cd is (0.576 ± 0.023)e$^2$b$^2$ and agrees well with the value of (0.567 ± 0.018)e$^2$·b$^2$ by Glenn and Saladin but disagrees with the recent value of (0.509 ± 0.009)e$^2$·b$^2$ by Simpson et al. obtained in the course of their measurement of the static quadrupole moment of the 2$^+$ state. Ge(Li) detectors were used to measure the angular distribution of $\gamma$-rays following Coulomb excitation with 11 MeV $^4$He ions in $^{106-116}$Cd. The angular distributions of the $\gamma$-rays from the 2′ → 2 transition by direct E2 Coulomb excitation were obtained with an accuracy sufficient to establish the magnitude and sign of $\delta \equiv \langle 2\|\mathcal{M}(E2)\|2'\rangle/\langle 2\|\mathcal{M}(M1)\|2'\rangle$. The values for $\delta$ are near −1.5 for $^{108,110,114,116}$Cd, $-(8.4^{+\infty}_{-1.0})$ or $-(0.6 \pm 0.2)$ and $-(3.5^{+\infty}_{-1.0})$ or $-(0.87 \pm 0.10)$ for $^{106}$Ce and $^{112}$Cd, respectively. The B(M1 2′ → 2) are large, being between (0.4 and 3) × 10$^{-2}$ (e$\hbar$/2Mc)$^2$. In addition, the angular distributions of the $\gamma$-rays from the 2″ → 2 transitions in $^{112}$Cd and $^{114}$Cd were determined and are consistent with two positive values of $\delta$. Improved values for the branching ratio of cascade/crossover transitions for the decay of the 2′ and 2″ states were obtained. With this information the ratios B(E2, 2′ → 2)/B(E2, 2 → 0) were

revised downward 10 to 40% from those given in a previous paper. The $2^+$ state in $^{106}$Cd and $^{108}$Cd is above the $4^+$ state in energy. (auth)

**31004** ELASTIC AND INELASTIC SCATTERING OF FAST NEUTRONS BY THE DEFORMED NUCLEUS $^{238}$U. Buehler, F. (Univ., Stuttgart). Z. Naturforsch., 24a: 52-63(Jan, 1969). (In German).

The elastic scattering and inelastic direct processes of fast neutrons with $^{238}$U are calculated in the framework of a deformed optical nuclear potential. The determination of the form factor of this potential follows through the generalization of the equivalent local Perey–Buck potential with the addition of a spherically symmetric spin–orbit coupling. The target nucleus is described by the collective model, and the coupled system of Schroedinger equations for the radial wave functions with the generalized equivalent local potential is integrated using the effective mass approximation to the target nucleus and numerical approximation methods. The effective cross section obtained for this system is compared to that obtained by the DWBA method. The effect of higher rotational states of $^{238}$U on the elastic and inelastic scattering is considered. The deformation parameter is estimated from Coulomb excitation experiments, and its ultimate magnitude is ascertained through comparison of the theory with scattering experiments. (tr-auth)

**31005** PRECISION GAMMA-RAY SPECTROSCOPY ON THE DECAY OF $^{169}$Tm. Keller, G. E. (Louisiana State Univ., Baton Rouge); Zganjar, E. F.; Pinajian, J. J. Nucl. Phys., A129: 481-501(1969).

Precision $\gamma$-ray energy and intensity measurements were made on the decay of 87 d $^{169}$Tm. The uncertainty in energy of the more prominent $\gamma$ rays ranged from 20 to 40 eV, and the uncertainty in the relative intensity varied from 1 to 5%. The available conversion electron intensity data were used with the data here to calculate internal conversion coefficients. A decay scheme consistent with these results is presented, and several ambiguities of the previous $^{169}$Tm decay schemes were resolved. The E2 branching ratios from the $\gamma$ vibrational band to the ground state were calculated and, when compared to band-mixing theory, gave the following values for the vibration-rotation coupling parameter $z_2$: 0.0278 ± 0.0055, 0.0284 ± 0.0091, 0.0283 ± 0.0056, 0.0314 ± 0.0025, and 0.0329 ± 0.0015. A weighted average of the above values is 0.0320 ± 0.0013. (auth)

**31006** FRACTIONAL CUMULATIVE YIELDS OF $^{103}$Mo, $^{105}$Mo, AND $^{106}$Mo FROM THERMAL-NEUTRON INDUCED FISSION OF $^{235}$U. Hastings, J. D. (Univ. of Missouri, Columbia); Troutner, D. E.; Ferguson, Robert L. Radiochim. Acta, 11: 51-6(Mar, 1969).

The fractional cumulative fission yields of $^{103}$Mo, $^{105}$Mo and $^{106}$Mo were measured by determining the amounts of $^{103}$Ru, $^{105}$Rh and $^{106}$Ru growing into molybdenum and technetium quickly separated from neutron-irradiated solutions of $^{235}$U. The yields, each expressed as a fraction of the total chain, are 1.007 ± 0.014, 0.983 ± 0.016, and $1.065^{+0.035}_{-0.037}$ for $^{103}$Mo, $^{105}$Mo, and $^{106}$Mo, respectively. Since the fractional cumulative yields of molybdenum are high, technetium independent yields must be low. The relation of these yields to others in the same mass region and in the complementary mass region is discussed. (auth)

**31007** ELECTROMAGNETIC TRANSITION STRENGTHS IN $^{206}$Pb, $^{207}$Pb, AND $^{208}$Pb FROM THRESHOLD PHOTONEUTRON CROSS-SECTION MEASUREMENTS. Bowman, C. D. (Univ. of California, Livermore); Berman, B. L.; Jackson, H. E. Phys. Rev., 178: 1827-36(Feb. 20, 1969).

The photoneutron cross sections for $^{206}$Pb, $^{207}$Pb, and $^{208}$Pb were measured for photon energies up to 40 keV above threshold. Several resonances were resolved for each isotope. Most of the resonances seen in the $^{207}$Pb and $^{208}$Pb spectra correspond to resonances detected by neutron-capture or total cross-section measurements on $^{206}$Pb and $^{207}$Pb, respectively. Values for $\Gamma_{\gamma 0}$, the ground-state $\gamma$-ray width, were determined for a number of resonances in each target. By comparison with the neutron-capture experiments, the multipolarities of the $\gamma$-ray transitions were determined, and an average $\gamma$-ray transition strength was obtained. The M1 transition strengths for $^{206}$Pb and $^{207}$Pb were found to be markedly enhanced over the expected value. One E2 transition in $^{208}$Pb was found to have a strength of 0.14 Weisskopf units, and there is a possibility of two other E2 transitions with similar strength. (auth)

**31008** BISMUTH L-SUBSHELL FLUORESCENCE YIELDS AND COSTER–KRONIG TRANSITION PROBABILITIES FROM DECAY OF $^{210}$Pb (RaD). Freund, H. U.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., 178: 1952-60(Feb. 20, 1969).

Ultrahigh-resolution (436-eV full width at half-maximum at 14.4 keV) Ge(Li) and Si(Li) x-ray detectors have been used to investigate L x rays of Bi from the decay of carrier-free $^{210}$Pb (RaD). A detailed study of the detection efficiencies was carried out, in order to take into account effects due to Ge K x-ray escape, and absorption in layers of inactive Ge or Si, Au, Al, and Be present between the source and active detector volume. A DuPont curve-resolving analog computer was used to resolve the L x-ray spectrum into further components. The resolved spectra thus yielded 10 L x-ray groups, together with their absolute intensities in $^{210}$Pb decay. Combining these results with recent precision L-conversion and L Auger electron absolute intensities in this decay, the following set of L-subshell fluorescence yields ($\omega_i$), Auger yields ($a_i$), and Coster–Kronig transition probabilities ($f_{ij}$) are obtained: $\overline{\omega}_L = 0.330 \pm 0.016$, $\omega_3 = 0.345 \pm 0.018$, and $\omega_1 = 0.095 \pm 0.005$; $\overline{a}_L = 0.670 \pm 0.016$, $\overline{a}_3 = 0.655 \pm 0.018$, and $\overline{a}_1 = 0.133 \pm 0.009$, and $f_{12} + f_{13} = 0.772 \pm 0.011$. Using the recent value of $f_{23} = 0.164 \pm 0.016$ at Z = 82, determined by Rao et al., the following additional quantities are evaluated: $\omega_2 = 0.23 \pm 0.02$, $a_2 = 0.61 \pm 0.02$, $f_{12} = 0.18 \pm 0.02$, and $f_{13} = 0.58 \pm 0.02$. A remarkably strong E2 L x-ray transition ($L_1 - M_{4,5}$) also was observed in the decay of $^{210}$Pb (RaD). (auth)

**31009** DECAY OF 7-MIN $^{168}$Lu AND LEVELS OF $^{168}$Yb. Wilson, R. G. (Hughes Research Labs., Malibu, Calif.). Phys. Rev., 178: 1949-51(Feb. 20, 1969).

New data for the 7-min activity of $^{168}$Lu are presented and combined with recent data on the levels of $^{168}$Yb to assign the following levels (energies and spins) in $^{168}$Yb populated by the decay of 7-min $^{168}$Lu: 87.5 keV, 2 + 0 (ground-state rotational); 986 keV, 2 + 2 ($\gamma$-vibrational); 1233 keV, 2 + 0 ($\beta$-vibrational); 1410 keV, (1 − 0?, octupole vibrational?); 1550 keV (?); 2002 keV, 2±; and 2127 keV, 1±, or 2195 keV, 2±. The spin of $^{168}$Lu is probably 1− or 2+. The 2-h activity of $^{168}$Lu may also be created by the 6-MeV proton bombardment of $^{168}$Yb. The upper limit for positrons in the 7-min $^{168}$Lu decay can be 20 to 30%, rather than the originally reported 1%. (auth)

**31010** NUCLEAR LEVELS IN $^{186}$Re. Lanier, R. G. (Florida State Univ., Tallahassee); Sheline, R. K.; Mahlein, H. F.; (and others). Phys. Rev., 178: 1919-48(Feb. 20, 1969).

Nuclear levels in $^{186}$Re were investigated by combining the following experimental techniques: the study of (d,p) and (d,t) reactions with 12-MeV deuterons and a broad-range magnetic spectrograph; the investigation of $\gamma$ transitions between 3.6 and 6.2 MeV from neutron capture using a Ge(Li) spectrometer; the measurement of (n,$\gamma$) radiation between 28 and 770 keV with a bent-crystal spectrometer; and the measurement of the (n,$e^-$) spectrum in the energy range 0–350 keV with a magnetic $\beta$ spectrometer. With the aid of (d,p) angular distributions and transition multipolarities, the energy levels up to an excitation energy of approximately 500 keV were interpreted as arising from the coupling of the proton orbital [402↑] to the neutron orbitals [512↓], [510↑], and [503↑]. A possible proton excited state at 314 keV was classified as resulting from the configuration p[514↑]; n[512↓]. Many higher-lying levels were also observed. A Coriolis band-mixing calculation was performed in an attempt to understand further the $^{186}$Re level structure below 500 keV. The (d,p) intensity pattern of the ground-state rotational band is in considerable disagreement with theoretical prediction, and it is suggested that residual interaction effects may be severely distorting the simple two-particle wave functions of the low-lying configurations. (auth)

**31011** ISOBARIC-ANALOG STUDIES WITH $^{107}$Ag AND $^{109}$Ag. Shugart, C. G.; Curry, J. R.; Lock, G. A.; Moore, P. A.; Riley, P. J. (Univ. of Texas, Austin). Phys. Rev., 178: 1836-44 (Feb. 20, 1969).

Proton-induced analog resonance reactions were studied using the targets $^{107}$Ag and $^{109}$Ag. Excitation functions were measured for the elastic and inelastic scattering of protons at laboratory angles of 90°, 120°, 150°, and 170° in the proton energy range from 5.9 to 7.25 MeV. Excitation functions for the (p,n) reaction were measured at an angle of 90° over the same energy range. Resonance energies, widths, and proton orbital-angular-momenta transfer values were obtained by analysis of the data. Comparisons were made with previous (p,n) and (d,p) measurements on the same target nuclei. (auth)

**31012** PAIRING EFFECTS AT THE FISSION SADDLE POINT OF $^{210}$Po AND $^{211}$Po. Moretto, L. G. (Univ. of California, Berkeley); Gatti, R. C.; Thompson, S. G.; Huizenga, J. R.; Rasmussen, J. O. Phys. Rev., 178: 1845-54(Feb. 20, 1969).

The fission-fragment angular distributions were measured for $^4$He-induced fission of $^{206}$Pb and $^{207}$Pb targets. The compound nuclei $^{210}$Po and $^{211}$Po were obtained at excitation energies ranging from 3 to 20 MeV above the fission barriers. The experimental data

were fitted by a theoretical expression relating the angular distribution of fission fragments to the distribution of the total angular momentum I and of the angular momentum projection K on the nuclear symmetry axis at the saddle point. By a least-squares fitting procedure, the variance $K_0^2$ of the K distribution was obtained. In the case of the even-even nucleus $^{210}$Po, the $K_0^2$ value approaches zero at about 3 MeV above the barrier, while in the case of the odd-A nucleus $^{210}$Po, $K_0^2$ remains rather large: This indicates the presence of the pairing gap in $^{210}$Po and of the residual quasiparticle in $^{211}$Po. Furthermore, the approximately constant difference in $K_0^2$ between the even-even and odd-A nucleus at corresponding energies is consistent with the expected contribution of a single quasiparticle to $K_0^2$. From the analysis of the data, the value of the pairing gap $2\Delta$ at the saddle point of $^{210}$Po is estimated to be about 4 MeV, about two to three times larger than in the ground state. The odd-even differences of saddle-point masses are also analyzed and the dependence of pairing on the nuclear surface is discussed. (auth)

**31013** EXPERIMENTAL STUDY OF THE (d,t) REACTION ON EVEN-MASS Mo ISOTOPES. Ohnuma, H.; Yntema, J. L. (Argonne National Lab., Ill.). Phys. Rev., 173: 1855-63(Feb. 20, 1969).

The (d,t) reaction on $^{92,94,96,98}$Mo was studied with the 23-MeV deuteron beam from the Argonne cyclotron. The experimental angular distributions of triton groups were compared with the distorted-wave Born approximation (DWBA) theory, and the l values and the spectroscopic factors were determined. The level structure of the $^{91}$Mo nucleus is very similar to that of $^{89}$Zr. Evidence for core excitation in $^{92}$Mo was found. The results for the other isotopes show that neutron orbits higher than the $2d_{\frac{5}{2}}$ shell are admixed in the ground-state configuration of these nuclei. These results are compared with previous data and with shell-model calculations. (auth)

**31014** PRODUCTION OF $^{111}$In AND $^{114m}$In FROM THE SEPARATED ISOTOPES OF CADMIUM USING 70- TO 400-MeV PROTONS. Nieckarz, W. J. Jr.; Caretto, A. A. Jr. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., 178: 1887-93(Feb. 20, 1969).

The cross sections for the $^{110+x}$Cd(p,xn)$^{111}$In and the $^{113+x}$Cd (p,xn)$^{114m}$In reactions at proton energies from 70 to 400 MeV were measured using the separated isotopes of cadmium as targets. The energy dependence of the (p,n), (p,2n), and (p,3n) reactions is inversely proportional to the incident energy over the entire energy region, while the (p,4n) and (p,6n) reactions exhibit this energy dependence only above 150 MeV. This similar energy dependence of the (p,xn) reactions supports the conclusion that these reactions take place by the same mechanism: a p-n cascade step followed by the evaporation of x − 1 neutrons. The change in the energy dependence of the (p,4n) and (p,6n) reactions below 100 MeV is probably due to contributions from compound-nucleus processes. The experimental results are compared with Monte Carlo cascade and evaporation calculations. (auth)

**31015** DELAYED $\gamma$ RAYS BETWEEN 2 AND 80 $\mu$SEC AFTER $^{235}$U (n,f) AND $^{239}$Pu(n,f). Walton, R. B.; Sund, R. E. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Rev., 178: 1894-1903 (Feb. 20, 1969).

Measurements of the energy spectrum of delayed $\gamma$ rays from the neutron fission of $^{239}$Pu and $^{235}$U were performed with a NaI detector at a number of time intervals between 2 and 80 $\mu$sec. The data showed three new prominent $\gamma$ rays with energies of 205, 390, and 1330 keV, two unresolved $\gamma$ rays having energies of approximately 110 keV, and the six $\gamma$ rays with energies of 260, 460, 720, 850, 910, and 1250 keV which were observed in previous studies for t > 50 $\mu$sec after fission. Absolute intensities of the new $\gamma$ rays were obtained using the normalization factor derived from the relative intensities of the last six $\gamma$ rays and their previously determined absolute intensities. The 205-, 390-, and 1330-keV $\gamma$ rays probably result from the cascade decay of a single isomer which has a half-life of 3.4 ± 0.4 $\mu$sec and fission yields of (1.30 ± 0.30) and (0.63 ± 0.20)% per fission of $^{239}$Pu and $^{235}$U, respectively. Half-lives and yields were also obtained for the unresolved 110-keV photopeaks, but these results are tentative because of uncertainties in the data. The fission yields, cascade $\gamma$ rays, and half-lives of the isomers responsible for early delayed $\gamma$ rays from $^{235}$U(n,f) and $^{239}$Pu(n,f) are summarized, and total intensities and energy emission rates of $\gamma$ rays with energies greater than 140 keV are presented as a function of time after fission over the range from 2 $\mu$sec to 25 msec. (auth)

**31016** NEUTRON ACTIVATION CROSS SECTIONS FOR MERCURY ISOTOPES AT 14.1 MeV. Temperley, J. K. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Phys. Rev., 178: 1904-10(Feb. 20, 1969).

Fast-neutron activation cross sections for the mercury isotopes have been measured relative to the $^{56}$Fe(n,p)$^{56}$Mn cross section. Enriched and natural-isotopic-abundance samples of Hg compounds were irradiated with 14.1 ± 0.5-MeV neutrons. The activities produced were determined by observing the $\gamma$ radiation with a Ge(Li) detector. The following cross sections (in millibarns) were determined: $^{196}$Hg(n,2n)$^{195m}$Hg, 1060 ± 70; $^{198}$Hg(n,2n)$^{197m}$Hg, 900 ± 70; $^{198}$Hg(n,2n)$^{197g}$Hg, 940 ± 100; $^{198}$Hg(n,p)$^{198}$Au, 4.7 ± 0.3; $^{199}$Hg(n,p) $^{199}$Au, 4.6 ± 0.6; $^{200}$Hg(n,2n)$^{199m}$Hg, 880 ± 60; $^{200}$Hg(n,$\alpha$)$^{197}$Pt, 0.2 ± 0.1; $^{201}$Hg(n,p)$^{201}$Au, 1.5 ± 0.7; and $^{204}$Hg(n,2n)$^{203}$Hg, 2060 ± 190. (auth)

**31017** RESONANCE SCATTERING OF NICKEL CAPTURE $\gamma$ RAYS FROM A NATURAL TELLURIUM TARGET. Schlesinger, Y. (Nuclear Research Center, Negev, Israel. Bar-Ilan Univ., Ramat-Gan, Israel); Hass, M.; Arad, B.; Ben-David, G. Phys. Rev., 178: 2013-19(Feb. 20, 1969).

The complex spectrum of resonantly scattered nickel neutron-capture $\gamma$ rays from a natural tellurium target is shown to be predominantly associated with transitions from a 7.538-MeV excited level in $^{130}$Te to several low-lying levels. The experiments were performed at a tangential-beam tube facility of the IRR-2 reactor, using a nickel source placed adjacent to the reactor core. A large-volume lithium-drifted germanium detector was used to measure the $\gamma$ spectrum. Coincidence measurements were performed using two sodium iodide crystals. (auth)

**31018** NUCLEAR STRUCTURE OF $^{205}$Pb FROM THE (d,t) REACTION. Tickle, Robert; Bardwick, John (Univ. of Michigan, Ann Arbor). Phys. Rev., 178: 2006-12(Feb. 20, 1969).

The structure of $^{205}$Pb was investigated using the neutron pickup reaction $^{206}$Pb(d,t)$^{205}$Pb at a bombarding energy of 21.6 MeV. A distorted-wave analysis (DWA) was made of the angular distributions of seven triton groups that excite ten levels in $^{205}$Pb. The spectrum is sparse; most of the strength corresponding to pickup from a given orbital in the target is contained in a single level. Configuration assignments and spectroscopic factors derived from the DWA are found to agree well with a shell-model calculation of the structure of $^{205}$Pb by Miranda. (auth)

**31019** ELECTRON-CAPTURE DECAY OF $^{207}$Bi: L-SUBSHELL FLUORESCENCE YIELDS AND COSTER-KRONIG TRANSITION PROBABILITIES OF Pb. Rao, P. Venugopala (Emory Univ., Atlanta); Wood, R. E.; Palms, J. M.; Fink, R. W. Phys. Rev., 178: 1997-2006(Feb. 20, 1969).

Coincidence spectrometry with high-resolution Si(Li) and Ge(Li) x-ray spectrometers (resolutions 470-eV full width at half-maximum at 14.4 keV) was employed to study directly the x rays emitted during the filling of each of the three L-subshell primary vacancies in the electron-capture decay of $^{207}$Bi. The L x rays, observed in the Si(Li) detector, in fast coincidence ($2\tau$ = 110 nsec) with $K_{\alpha 1}$ x rays detected in the Ge(Li) detector, arise entirely from initial vacancies in the $L_3$ subshell, while those in coincidence with $K_{\alpha 2}$ x rays are from initial $L_2$-subshell vacancies. The clear presence of $L_\alpha$ x rays, which arise only from $L_3$ vacancies, in the latter spectrum indicates that Coster–Kronig transitions of the type $L_2$-$L_3X$ take place. The L x rays in coincidence with 1770-, 1063-, and 570-keV $\gamma$ rays and with 1063-keV L-conversion electrons give information on $L_1$-subshell quantities. The following results are obtained: $\omega_3$ = 0.315 ± 0.013, $\omega_2$ = 0.363 ± 0.015, $\omega_1$ = 0.07 ± 0.02, $\nu_1$ = 0.295 ± 0.010, $\nu_2$ = 0.417 ± 0.015, $f_{12}$ = 0.15 ± 0.04, $f_{13}$ = 0.57 ± 0.03, and $f_{23}$ = 0.164 ± 0.016 at Z = 82. (auth)

**31020** $^{208}$Pb(d,t) AND (d,$^3$He) REACTIONS WITH 50-MeV DEUTERONS. Parkinson, W. C. (Univ. of California, Berkeley); Hendrie, D. L.; Duhm, H. H.; Mahoney, J.; Saundinos, J.; Satchler, G. R. Phys. Rev., 178: 1976-96(Feb. 20, 1969).

The absolute differential cross sections for the six lowest-lying levels of $^{207}$Pb and the five lowest-lying levels of $^{207}$Tl excited by the $^{208}$Pb(d,t) and (d,$^3$He) reactions, respectively, were measured for 50-MeV incident deuteron energy. In addition, the absolute differential cross sections were measured for the elastic scattering of 47.5-MeV $^3$He ions on $^{208}$Pb and the inelastic scattering on the well-known $3^-$ level at 2.615 MeV. The excitation energies and level assignments are in agreement with previous measurements. The measured cross sections, when compared using distorted-wave analysis, suggest that the effective proton shell-model potential may have a larger spatial extent than that for neutrons. In the analysis, the contributions from the nuclear interior to the distorted-wave amplitudes for the proton pickup had to be eliminated, but this was not necessary for the neutron pickup. The distorted-wave analysis is discussed in some detail. (auth)

**31021** BETA SPECTRUM OF $^{187}$W. Nagarajan, T.; Ravindranath, M.; Reddy, K. Venkata; Jnanananda, Swami (Andhra Univ., Waltair, India). Phys. Rev., 178: 1968-75(Feb. 20, 1969).

The $\beta$ spectrum of $^{187}W$ was analyzed with a thoroughly tested Siegbahn–Slatis $\beta$-ray spectrometer equipped with a plastic well-type detector, whose counting efficiency is unity down to 50 keV. The highest-energy group ($^3/_2^- \rightarrow {}^3/_2^+$) is nonunique first-forbidden with a log ft value 8.0, and it deviates from the statistical shape as a result of the selection-rule effect. Its shape could be fitted with that of a modified $B_{ij}$ approximation, namely, $C(W) = q^2 + 9L_1/L_0 + D$ with the value of $D = 23 \pm 3$. Though the calculations based on the Nilsson model and the j-j coupling shell model predict a deviation from the $\xi$ approximation, only the former could give better agreement with experiment. A detailed analysis of the shape factor yields the end point of the outer group as $1314 \pm 2$ keV. Subtraction of this outer group, corrected for its shape, revealed inner groups with maximum energies and intensities $625 \pm 5$ (66%), $453 \pm 7$ (3%), and $330 \pm 10$ (5%) keV. Information was also obtained on a few conversion lines which were resolved by the spectrometer. (auth)

**31022** USE OF THE $(\gamma,\gamma')$ REACTION FOR STUDYING $^{141}Pr$ LEVELS. Moreh, R.; Nof, A. (Nuclear Research Centre-Negev, Beer Sheva, Israel). Phys. Rev., 178: 1961-7(Feb. 20, 1969).

Elastic and inelastic scattering of monochromatic photons was used for studying the energy levels of $^{141}Pr$, the photons being produced by thermal-neutron capture in iron. The resonantly scattered spectrum was measured using Ge(Li) detectors. The energy of the resonance level in $^{141}Pr$ was found to be 7.632 MeV. Energies and intensities of several $\gamma$ lines were measured in the region 4.8 to 7.7 MeV. Assuming these lines to be inelastic transitions de-exciting the resonance level, 19 energy levels were found from the ground state up to 2.8 MeV, 8 of which may be identified with recently reported levels. Angular-distribution measurements of some lines in the scattered spectrum were carried out and the spins of several levels were determined. The parity of the scattering level was measured using a Compton polarimeter and was found to be odd, corresponding to E1 elastically scattered radiation. The total level width of the scattering level was determined using self-absorption and temperature-variation measurements and was found to be $\Gamma = 0.133 \pm 0.023$ eV. The $^{141}Pr$ levels are discussed in terms of the predictions of the pairing-correlation model. (auth)

**31023** INELASTIC SCATTERING OF 14.0-MeV PROTONS BY THE EVEN ISOTOPES OF CADMIUM. Lutz, H. F.; Bartolini, W.; Curtis, T. H. (Univ. of California, Livermore). Phys. Rev., 178: 1911-19(Feb. 20, 1969).

Angular distributions of 14.0-MeV protons scattered elastically and inelastically by targets of $^{106,108,110,112,114,116}Cd$ were obtained. Coupled-channel analysis was used to extract extended optical-model parameters that generate fits to the scattering data of the isotopic sequence. The analysis yielded deformabilities that were used to calculate equivalent electromagnetic-transition enhancement factors and ratios of B(E2) values, which were compared with the results of Coulomb-excitation studies. (auth)

**31024** EFFECT OF CORE PARTICLE–HOLE EXCITATIONS ON PROPERTIES OF VIBRATIONAL STATES. Gillet, Vincent; Giraud, Bertrand; Rho, Mannque (CEN de Saclay, Gif-sur-Yvette, France). Phys. Rev., 178: 1695-7(Feb. 20, 1969).

Energy levels and transition probabilities of single-closed-shell nuclei were calculated by mixing two-quasiparticle excitations into one-particle–one-hole core excitations in a phenomenological framework free of adjustable parameters. In particular, no effective charges were used. (auth)

**31025** STUDY OF THE J DEPENDENCE IN THE $(d,^3He)$ REACTION. Ohnuma, H.; Yntema, J. L. (Argonne National Lab., Ill.). Phys. Rev., 178: 1654-62(Feb. 20, 1969).

The J dependence of the angular distributions in the $(d,^3He)$ reactions was experimentally observed at small angles in the 2p proton pickup. This J dependence is qualitatively reproduced by distorted-wave calculations which indicate that the effect arises mainly from the deuteron spin-orbit potential. The calculated angular distributions are strongly dependent on the Q value of the reactions and the incident deuteron energy. The calculations also show that the J dependence is localized at the surface of the nucleus, and is very sensitive to the volume of the real part of the deuteron optical potential. This sensitivity may be understood by considering the role of the spin-orbit term in the optical potential. The sensitivity of the calculated angular distributions to the other parameters is investigated. (auth)

**31026** THE MEASUREMENT OF ABSOLUTE DELAYED-NEUTRON YIELDS FROM 3.1- AND 14.9-MeV FISSION. Masters, Christopher F.; Thorpe, M. M.; Smith, Darryl B. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 36: 202-8(May 1969).

A new method, utilizing a modulated neutron source operated in antisynchronism with a long counter, has been used to measure the absolute and relative delayed-neutron yields of five fissionable isotopes for neutron-induced fission at 3.1 and 14.9 MeV. The isotopes studied were $^{239}Pu$, $^{233}U$, $^{235}U$, $^{238}U$, and $^{232}Th$. The data are in accord with qualitative theoretical predictions but are in marked disagreement with earlier measurements. (auth)

**31027** SUPERFLUIDITY CORRECTIONS BY USING THE WOODS–SAXON POTENTIAL FOR SOME TRANSITIONS IN DEFORMED NUCLEI. Bogdan, D.; Fuia, H.; Protop, C.; Vata, I. (Inst. for Atomic Physics, Bucharest. Polytechnic Inst., Bucharest). Bul. Inst. Politeh. Gheorghe Gheorghiu-Dej Bucuresti, 30: No. 5-6, 51-4(Sept.-Dec. 1968).

As there are great discrepancies between the theoretical and experimental values of the 1st order forbidden transition probabilities for deformed nuclei in the $150 < A < 188$ region, the superfluidity corrections and the (fct)w-s, (fct)N, values were computed by using the Woods–Saxon and Nilsson potentials. The correct evolution of the matrix elements were taken into account in the basis of the CVC theory. The results obtained show a large interdiction both in the case of the Woods–Saxon potential and in the Nilsson case. Part of this interdiction may be explained by means of the configuration mixing (for instance for $^{170}Tm$). (auth)

**31028** DECAY PROPERTIES OF $^{249}Bk$ AND $^{249}Cf$. Milsted, J.; Horwitz, E. P.; Friedman, A. M.; Metta, D. N. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 31: 1561-9(June 1969).

The following decay properties were measured: the alpha/beta branching ratio of $^{249}Bk$, $(1.45 \pm 0.08) \times 10^{-5}$, the alpha half-life of $^{245}Cf$, $345 \pm 15$ yr, the spontaneous fission half-life of $^{249}Bk$, $(1.87 \pm 0.09) \times 10^9$ yr, and the spontaneous fission half-life of $^{249}Cf$, $(6.87 \pm 0.33) \times 10^{10}$ yr, which appears to be anomalously long. Observations of the alpha particle spectra of these two nuclides are also reported. (auth) (UK)

**31029** MULTIPOLARITIES OF SEVERAL TRANSITIONS IN $^{227}Ac$. Barnett, A. G.; Campbell, A. R.; Hagee, G. R. (Mound Lab., Miamisburg, Ohio). J. Inorg. Nucl. Chem., 31: 1553-9 (June 1969).

Internal conversion coefficients were measured and multipolarity assignments were made for several transitions of $^{227}Ac$. The K- and/or L-shell internal conversion coefficients of the 313.0, 330.2, 341.0, and 356.6 keV transitions in $^{227}Ac$ were determined using calibrated Ge(Li) and Si(Li) spectrometers. Results indicate that the 313.0 transition is a retarded E1 transition giving rise to a predominantly M2 radiation character. The 330.2 keV transition is a mixture of M1 + E2 radiation, and the 356.6 keV transition is essentially pure M1. The 341.0 keV transition probably has E1 + M2 radiation character. Implications of these results on the decay scheme are discussed. (auth) (UK)

**31030** THE 65-MeV HELIUM ION-INDUCED FISSION OF $^{194}Pt$, $^{195}Pt$, AND $^{196}Pt$. Neuzil, E. F.; Apt, K.; Hensley, W.; Assink, D. (Western Washington State Coll., Bellingham). J. Inorg. Nucl. Chem., 31: 1575-8(June 1969).

The 65-MeV helium ion-induced fission of enriched platinum isotopes $^{194}Pt$, $^{195}Pt$, and $^{196}Pt$ reported is consistent with the previous trends found. The fission fragment mass distribution curves are all Gaussian in shape with the even-even species $^{194}Pt$ and $^{196}Pt$ yielding curves which appear to be slightly wider ($24 \pm 1$ mass units wide) than the even-odd species $^{195}Pt$ ($22 \pm 1$ mass units wide). The slope of the width at half maximum ($W_{\frac{1}{2}}$) function is almost constant for the even-odd $^{195}Pt$ over the energy range studied, whereas the slope of the half width function for the even-even nuclides appears to be reaching a plateau at higher excitation energies. (auth)

**31031** COMPARISON OF THE $^{197}Au(p,FISSION)$ TO THE $^{194}Pt(\alpha,FISSION)$ AT AN EXCITATION OF 40.5 MeV. Neuzil, E. F.; Apt, K. (Western Washington State Coll., Bellingham). J. Inorg. Nucl. Chem., 31: 1571-4(June 1969).

Using standard radiochemical techniques, the charged-particle induced fission of $^{198}Hg$ was studied by the formation of this species by means of protons on $^{197}Au$ and helium ions on $^{194}Pt$ to yield the compound nucleus in the same excitation level. At the 40.5 MeV excitation the two fission reactions produced nearly identical fission-fragment mass distribution curves, with a width at half maximum ($W_{\frac{1}{2}}$) of $21 \pm 1$ a.m.u. The proton-induced fission cross section was 140 $\mu$barns, the helium ion-induced fission was only 22 $\mu$barns. It is postulated that this effect may be due to the relative deposition of angular momentum into each target nucleus, resulting in a partition of excitation energy into vibrational and rotational states which is different in each case, resulting in different probabilities for fission due to the different mode of compound nucleus formation. (auth) (UK)

**31032** DISTRIBUTION OF CHARGE IN $^{232}$Th AND $^{238}$U DETERMINED BY MEASUREMENTS ON MUONIC X RAYS. Cote, R. E. (Argonne National Lab., Ill.); Prestwich, W. V.; Geigalas, A. K.; Raboy, S.; Trail, C. C.; Carrigan, R. A. Jr.; Gupta, P. D.; Sutton, R. B.; Suzuki, M. N.; Thompson, A. C. Phys. Rev., 179: 1134-47(Mar. 20, 1969).

The energies and intensities of the x rays of muonic atoms of $^{232}$Th and $^{238}$U were measured. Analysis of the data was performed using the rotational model of strongly deformed nuclei to include dynamic quadrupole interactions. The distribution of nuclear charge was represented by a modified Fermi distribution which involves three parameters, namely, the intrinsic quadrupole moment $Q_0$, the half-density radius $c = c_0A^{\frac{1}{3}}$, and the skin thickness t. It was found that the allowed ranges of values for $Q_0$, $c_0$, and t were for thorium 9.58−9.83 b, 1.155−1.143 F, and 1.54−1.87 F, and for uranium 11.20−11.41 b, 1.150−1.142 F, and 1.600−1.87 F, respectively. However, if specific values for two of these parameters are chosen, the third is determined with an error smaller than the above ranges: 0.5% for $Q_0$, 0.25% for $c_0$, and 0.6% for t. (auth)

**31033** K X RAYS FROM FISSION FRAGMENTS FORMED IN ASSOCIATION WITH LONG-RANGE ALPHA-PARTICLE EMISSION. Watson, R. L. (Texas A and M Univ., College Station). Phys. Rev., 179: 1109-12(Mar. 20, 1969).

The intensities of K x rays emitted in coincidence with long-range $\alpha$ particles arising from the spontaneous fission of $^{252}$Cf were measured with a high-resolution lithium-drifted silicon spectrometer. A comparison of the observed x-ray intensity distribution with the x-ray intensity distribution resulting from binary fission shows that, aside from an increase in the x-ray intensities for the lower atomic number members of the light and heavy fragment groups and a decrease in the x-ray intensities for the higher atomic number members in fission associated with long-range $\alpha$ emission, the general structural features are quite similar. Calculations based upon the two-step and one-step hypotheses of long-range $\alpha$-particle emission indicate a deviation from the "expected" intensity for xenon isotopes. (auth)

**31034** NEUTRON-CAPTURE GAMMA-RAY STUDIES OF THE LEVEL STRUCTURE OF THE $^{124}$Te NUCLEUS. Bushnell, D. L. (North Illinois Univ., DeKalb. Argonne National Lab., Ill.).; Chaturvedi, R. P.; Smither, R. K. Phys. Rev., 179: 1113-33(Mar. 20, 1969).

The $\gamma$-ray spectrum resulting from thermal-neutron capture in $^{123}$Te was investigated with the Argonne 7.7-m bent-crystal spectrometer. The observed spectrum consisted of 75 $\gamma$ rays with energies between 100 keV and 1.1 MeV. The spectrometer used a new split source technique which allowed simultaneous measurement of the $^{123}$Te(n,$\gamma$)$^{124}$Te spectrum from capturing samples with two different isotopic enrichments of $^{123}$Te and thus gave immediate isotopic identification for the (n,$\gamma$) spectrum. The $^{123}$Te(n,$\gamma$)$^{124}$Te spectrum was also measured with Ge(Li) detectors in the energy regions 0.5−4.0 MeV (112 lines) and 5.5−9.5 MeV (63 lines) by use of the Argonne in-pile facility. The associated spectrometer has a long, split NaI ring which surrounds a Ge(Li) detector and was used to enhance the full-energy spectrum (anticoincidence) and the double-escape spectrum (coincidence). The above thermal-neutron-capture spectrum was combined with the results of an average-resonance-capture spectrum taken with the same Ge(Li) facility but with the target surrounded with boron. These (n,$\gamma$) experiments were then combined with all previous work to develop and extend the level scheme of $^{124}$Te and to define many of the details of the $\gamma$ decay of these levels. The new values for the first 15 level energies (keV) and $J^\pi$ are ground state, $0^+$; 602.42 ± 0.02, $2^+$; 1247.99 ± 0.05, $4^+$; 1324.82 ± 0.05, $2^+$; (1655.9 ± 0.2, $0^+$); (1736.5 ± 0.3); (1747.40 ± 0.16); 1956.18 ± 0.11, $3^+$, $4^+$; 2037.68 ± 0.07, $2^+$; 2090.65 ± 0.35, $0^+$, $2^+$; 2152.04 ± 0.15, $0^+$, $2^+$; 2181.20 ± 0.40, 1, 2; 2293.10 ± 0.30, $3^-$; 2322.57 ± 0.20, $0^+$, $2^+$; 2452.9 ± 2.6, $0^+$, $2^+$. The parentheses indicate uncertainty in the level assignments, while the italic numerals indicate new spin and parity values. The relative intensities of $\gamma$ rays from states at ~2 MeV suggest that E2 transitions to the two-phonon states at 1248 and 1325 keV are enhanced relative to transitions to states at 0 and 602 keV; so these 2-MeV levels are very likely collective and possibly vibrational. The (n,$\gamma$) data imply a neutron binding energy $E_n$ = 9425 ± 2 keV for $^{124}$Te. (auth)

**31035** NEUTRON RESONANCES OF Mo ISOTOPES. Shwe, Hla; Cote, R. E. (Argonne National Lab., Ill.). Phys. Rev., 179: 1148-53(Mar. 20, 1969).

The neutron transmission of Mo isotopes for neutron energy $E_n \lesssim 1.5$ keV was measured with the Argonne fast chopper. The use of samples enriched in $^{95}$Mo and in $^{97}$Mo as well as samples of natural Mo made possible the unambiguous isotopic assignment of the resonances. Some ten new resonances were detected and measured; all of these were assigned to either $^{95}$Mo or $^{97}$Mo. On the basis of a probability approach recently suggested by Bollinger, a great majority of these newly observed resonances have been interpreted as being due to p-wave neutrons. For $^{95}$Mo, the mean radiation width calculated from the measurements for the resonances at $E_0$ = 44.7 and 159.6 eV is $\langle\Gamma_\gamma\rangle_{l=0}$ = 185 ± 15 MeV. This is to be compared with $\langle\Gamma_\gamma\rangle_{l=1}$ = 277 ± 67 MeV for the two p-wave resonances at $E_0$ = 110.3 and 117.9 eV. For $^{96}$Mo, the widths are $\langle\Gamma_\gamma\rangle_{l=0}$ = 330 ± 50 MeV for the resonance at 131.3 eV, and $\langle\Gamma_\gamma\rangle_{l=1}$ = 530 ± 100 MeV for the resonance at $E_0$ = 113.5 eV. For $^{97}$Mo, the radiation widths are $\langle\Gamma_\gamma\rangle_{l=0}$ = 127 ± 13 MeV for the s-wave resonance at $E_0$ = 70.9 eV and $\langle\Gamma_\gamma\rangle_{l=1}$ = 154 ± 20 MeV for four of the p-wave resonances detected in this experiment. The values for $^{98}$Mo are $\langle\Gamma_\gamma\rangle_{l=0}$ = 170 ± 80 MeV for the s-wave resonance at $E_0$ = 428.9 eV, and $\langle\Gamma_\gamma\rangle_{l=1}$ = 110 ± 15 MeV for the p-wave resonance at $E_0$ = 12.1 eV. The strength functions calculated for these nuclides are $S_0(^{95}\text{Mo}) = (0.5) \times 10^{-4}$, $S_1(^{95}\text{Mo}) = (5) \times 10^{-4}$; $S_0(^{97}\text{Mo}) = (0.5) \times 10^{-4}$, $S_1(^{97}\text{Mo}) = (6) \times 10^{-4}$; and $S_0(^{98}\text{Mo}) = (2) \times 10^{-4}$. The resonance-capture integral for natural Mo was calculated to be 27 ± 2 b. (auth)

**31036** SPINS AND WIDTHS OF ENERGY LEVELS IN THE 5 TO 9 MeV REGION. Ramchandran, S.; McIntyre, J. A. (Texas A and M Univ., College Station). Phys. Rev., 179: 1153-65 (Mar. 20, 1969).

Neutron-capture $\gamma$ rays from the Texas A&M research reactor were used to excite one nuclear energy level each in $^{90}$Zr, Cd, Sn, Hg, $^{205}$Tl, and $^{208}$Pb, and two in $^{209}$Bi, in the 5−9-MeV region. Angular-distribution measurements of the scattered $\gamma$ rays showed that the transitions were all consistent with dipole radiation. However, for various reasons, the data could also be reproduced in most cases by assuming a mixture of dipole and quadrupole radiation. Three further measurements were made for the $^{90}$Zr, the $^{205}$Tl, the $^{208}$Pb, and one $^{209}$Bi excitation: an absolute differential cross-section measurement on the resonance scattering, a resonance absorption measurement, and a differential cross-section measurement at liquid-nitrogen temperature. From these data, values were found for $\Gamma_0$ (the excited level width for an electromagnetic transition to the ground state), $\Gamma$ (the excited level total electromagnetic width), and $\epsilon$ (the energy displacement between the neutron-capture $\gamma$-ray energy and the resonance energy). The values of $\Gamma_0$ (between 0.14 and 1.0 eV) were found to be about 10 times larger than the values usually found for $\gamma$-ray widths in this energy region as determined from neutron-capture reactions. (auth)

**31037** XENON AND KRYPTON FROM THE SPONTANEOUS FISSION OF $^{252}$Cf. Srinivasan, B. (Univ. of Missouri, Rolla); Alexander, E. C. Jr.; Manuel, O. K.; Troutner, D. E. Phys. Rev., 179: 1166-9(Mar. 20, 1969).

The isotopic composition of xenon and krypton was measured in aluminum foils which were exposed to ~$10^{10}$ fissions of $^{252}$Cf. Relative to $^{136}$Xe, observed yields are $^{83}$Kr : $^{84}$Kr : $^{85}$Kr : $^{86}$Kr : $^{131}$Xe : $^{132}$Xe : $^{134}$Xe : $^{136}$Xe = 0.010 : 0.017 : 0.0049 : 0.032 : 0.35 : 0.52 : 0.90 : 1.000. These results show a higher relative yield at mass 134 and less fine structure in the 83−86 mass region than reported from energy-versus-time-of-flight studies on single fission fragments. The results do not confirm the sharp minimum in the fine structure at mass 136, as suggested from radiochemical studies in the mirror mass region. (auth)

**31038** GROUND-STATE SPIN OF $^{163}$Er. Stein, Sanford; Ramsey, Alan T. (Univ. of California, Berkeley). Phys. Rev., 179: 1170-1(Mar. 20, 1969).

The ground-state nuclear spin of 75-min $^{163}$Er was measured and found to be I = $\frac{5}{2}$, in agreement with the Nilsson-state assignment for the 95th neutron. (auth)

**31039** NUCLEAR STRUCTURE IN $^{113}$Cd FROM THE $^{112}$Cd (d,p) REACTION. Goldman, L. H. (Univ. of Pittsburgh); Kremenek, J.; Hinds, S. Phys. Rev., 179: 1172-6(Mar. 20, 1969).

The $^{112}$Cd(d,p)$^{113}$Cd reaction induced by 13-MeV deuterons was studied with the Aldermaston multigap spectrograph. Essentially all states up to 2.8 MeV were observed. Spins and parities, as well as spectroscopic factors were determined with the aid of distorted-wave Born-approximation (DWBA) calculations. Triton cross sections from the $^{114}$Cd(d,t)$^{113}$Cd reaction were used to determine which of the $l_n$ = 2 transitions led to $d_{\frac{3}{2}}$ levels and which led to $d_{\frac{5}{2}}$ levels. (auth)

**31040** ELECTRON- AND BREMSSTRAHLUNG-INDUCED FISSION OF HEAVY AND MEDIUM-HEAVY NUCLEI. Moretto, L. G. (Univ. of California, Berkeley); Gatti, R. C.; Thompson, S. G.; Routti, J. T.; Heisenberg, J. H.; Middleman, L. M.; Yearian, M. R.; Hofstadter, R. Phys. Rev., 179: 1176-87(Mar. 20, 1969).

The electron- and bremsstrahlung-induced fission cross sections of the isotopes $^{238}$U, $^{209}$Bi, $^{208}$Pb, $^{174}$Yb, and $^{154}$Sm were mea-

sured over the energy range 60 to 1000 MeV. The consistency of the theoretical expressions for the bremsstrahlung spectrum and the virtual-photon spectrum associated with the electron was tested using the experimental data. Good agreement was obtained on the assumption of E1 or M1 transitions. The photofission cross sections obtained on the basis of this procedure were analyzed in terms of the photon-interaction cross section and the fission probability. It was found that the rapid increase in the photofission cross section with increasing energy for $^{209}$Bi and the lighter isotopes is due to the normal increase in fission probability with energy, and not to the onset of $\pi$-meson photoproduction as was previously suggested. The photon-interaction cross section predicted by the quasideuteron model seems to account for all of the interaction leading to fission in these elements, even at energies above the threshold for $\pi$-meson production. In the case of $^{238}$U, however, since the fission probability is approximately constant as a function of energy, the fission cross-section behavior reflects the characteristics of the total photon-interaction cross section. In the latter case it was found that the $\pi$-meson photoproduction and the quasideuteron interaction are both involved in producing excitation leading to fission. The difference between the behavior of $^{238}$U and the lighter isotopes is understood in terms of differences in fission barriers and differences in energy deposition associated with the two interaction mechanisms. The asymmetric fission of $^{238}$U at high electron or bremstrahlung energies is also explained on this basis. (auth)

**31041** CHARGE DISTRIBUTION IN FISSION: FRACTIONAL CUMULATIVE FISSION YIELDS OF $^{143}$Ba AND $^{144}$Ba FROM THERMAL-NEUTRON-INDUCED FISSION OF $^{235}$U. Runnalls, N. G. (Univ. of Missouri, Columbia); Troutner, D. E.; Ferguson, Robert L. Phys. Rev., 179: 1188-93(Mar. 20, 1969).

Rapid chemical separations of Cs and Ba from La and Ce have been used to measure half-lives and cumulative yields of $^{143}$Ba and $^{144}$Ba from thermal-neutron-induced fission of $^{235}$U. The half-lives are 13.2 ± 0.3 sec for $^{143}$Ba and 11.9 ± 0.3 sec for $^{144}$Ba. The yields, each expressed as a fraction of the total chain, are 0.88 ± 0.06 and 0.78 ± 0.06 for $^{143}$Ba and $^{144}$Ba, respectively. Charge distribution for A = 144 can be represented by a Gaussian distribution with width parameter $\sigma = 0.52 \pm 0.02$ and $Z_p = 56.09 \pm 0.05$; for A = 143, $\sigma = 0.58 \pm 0.05$, and $Z_p = 55.87 \pm 0.05$, in agreement with previously reported values. Evidence is presented that charge distribution as determined from yields of several isotopes of the even-Z elements Xe, Ba, Kr, and Sr can be satisfactorily represented by a single Gaussian distribution with $\sigma = 0.56$. A possible even-odd effect in nuclear charge distribution from fission of $^{235}$U is noted. (auth)

**31042** EFFECT OF NUCLEAR POLARIZATION ON THE GIANT DIPOLE RESONANCE OF $^{165}$Ho. Kelly, M. A.; Berman, B. L.; Bramblett, R. L.; Fultz, S. C. (Univ. of California, Livermore). Phys. Rev., 179: 1194-1211(Mar. 20, 1969).

The $(\gamma,n)$ and $(\gamma,2n)$ cross sections of polarized $^{165}$Ho were measured between 10 and 21 MeV using the nearly monoenergetic photon beam from the annihilation in flight of fast positrons. Two independent cross sections were obtained by orienting the polarization axis of the target nuclei perpendicular to and parallel to the photon beam. From these, the cross sections corresponding to the intrinsic modes of the giant resonance were computed. The target consisted of nine single crystals of holmium metal having a total mass of 50 g, and was polarized by cooling to approximately 0.13°K in the presence of a 15-kOe magnetic field. The alignment parameter $f_2$ was determined to be 0.43 ± 0.05 by measuring the anisotropy of the $\gamma$ rays emitted by $^{165m}$Ho (created in the target by neutron activation). Both major peaks of the total photoneutron cross section, $\sigma_t = \sigma[(\gamma,n) + (\gamma,pn) + (\gamma,2n)]$, exhibited a dependence upon target orientation that agrees qualitatively with the collective model for deformed nuclei. The observed anisotropy was (74 ± 13)% of that predicted by hydrodynamic models. (auth)

**31043** STUDY OF THE $^{94}$Zr($^3$He,d)$^{95}$Nb REACTION. Ohnuma, H.; Yntema, J. L. (Argonne National Lab., Ill.). Phys. Rev., 179: 1211-13(Mar. 20, 1969).

The $^{94}$Zr($^3$He,d)$^{95}$Nb reaction was studied with 34-MeV $^3$He particles from the Argonne cyclotron. Experimental angular distributions were analyzed on the basis of the distorted-wave Born-approximation theory to determine the l values and spectroscopic factors. The results are compared with the previous data on the (d,$^3$He) reactions on Mo and Zr isotopes, and the proton configurations of the nuclei in this region are discussed. (auth)

**31044** $\beta$- AND $\gamma$-VIBRATIONAL BANDS OF $^{152}$Sm AND $^{154}$Gd. Riedinger, L. L. (Oak Ridge National Lab., Tenn.); Johnson, Noah R.; Hamilton, J. H. Phys. Rev., 179: 1214-1229(Mar. 20, 1969).

Employing radioactive sources of $^{152}$Eu (12.4 yr) and $^{154}$Eu (16 yr) in both $\gamma$-ray singles and $\gamma$-$\gamma$ coincidence experiments, the intensities of most of the weak $\gamma$-ray transitions depopulating the 0+, 2+, and 4+ members of the $\beta$-vibrational bands and the 2+, 3+, and 4+ members of the $\gamma$-vibrational bands in $^{152}$Sm and $^{154}$Gd were determined. From these $\gamma$-ray intensities, ratios of reduced E2 transition probabilities were determined and a detailed analysis of band mixing in these nuclei has been accomplished. Mixing of the $\beta$ and $\gamma$ bands into the ground-state rotational band and into each other was considered but was found to be grossly insufficient in explaining the B(E2) ratios from members of the $\beta$ band. However, this treatment does seem to be adequate in explaining the ratios from members of the $\gamma$ band in each nucleus. From the $\gamma$-ray intensities and literature values for the internal-conversion electron intensities and the reduced E2 transition probabilities, it was possible to evaluate the reduced nuclear matrix element $\rho$ for the electric-monopole transitions between the $\beta$ and ground-state bands in each nucleus. For $^{152}$Sm, $\rho$ was determined to be 0.28 ± 0.02, while only an estimate of 0.44 is possible for $^{154}$Gd. Values of X, the dimensionless ratio of the squares of the E0 to E2 reduced matrix elements, were determined and compared to the model predictions. The experimental values are generally 2.5 to 5 times smaller than predicted. Furthermore, the effects of nonadiabatic perturbations on the ground-state rotational band were considered. The contributions of centrifugal stretching to the observed energy shifts and to changes in radius within the rotational spectra can be estimated from the experimental determination of the band-mixing amplitudes. The results indicate that centrifugal stretching of the nucleus cannot explain the energy shifts in $^{152}$Sm and $^{154}$Gd but probably can account for the observed changes in radius for $^{152}$Sm and $^{154}$Gd. (auth)

**31045** MULTIPOLE ANALYSIS OF PARTICLE–PARTICLE OR PARTICLE–HOLE MULTIPLETS. Moinester, M. (Univ. of Rochester, N. Y.); Schiffer, J. P.; Alford, W. P. Phys. Rev., 179: 984-95(Mar. 20, 1969).

Recent data on particle-hole multiplets in $^{208}$Bi were analyzed in terms of the Racah multipole decomposition. The resulting multipole coefficients are very similar for the various multiplets. A comparison with other known multiplets in $^{38}$Cl, $^{39}$K, $^{42}$Sc, $^{48}$Sc, $^{50}$Sc, $^{92}$Nb, and $^{210}$Br also shows a remarkable similarity. These empirical results show that the spectra of such multiplets are determined reasonably well by one set of multipole coefficients, independent of the single-particle orbits involved. It has been pointed out by Kurath that a simple $\delta$-function two-body force with spin exchange fits these average multipole coefficients as well as more complicated interactions. (auth)

**31046** RECENT RESULTS ON ELECTRON CAPTURE. Berenyi, D. (Inst. of Nuclear Research, Debrecen, Hungary). pp 189-225 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25–28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.

See CONF-670981.

Some recent work on the electron-capture decay of nuclei is summarized. Some of the experimental problems encountered in electron capture studies are described. (155 references) (J.W.R.)

**31047** THE CORRECT USE OF THE CONSERVED VECTOR CURRENT THEORY IN THE FIRST-FORBIDDEN BETA DECAY OF $^{170}$Tm. Bogdan, D.; Vata, I. (Inst. for Atomic Physics, Bucharest). pp 301-5 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25–28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.

See CONF-670981.

The nuclear matrix elements and log ft values for $\beta^-$ transitions in $^{170}$Tm were calculated using Woods–Saxon wave functions. The relativistic matrix was calculated in the framework of CVC theory. Considerable improvement was found over Nilsson model calculations for the same transitions. (J.W.R.)

**31048** INFLUENCE OF NUCLEAR STRUCTURE ON THE VALUE OF THE K/$\beta^+$ RATIO IN THE 797-keV DECAY OF $^{178}$Ta. Eman, B.; Tadic, D. (Inst. Ruder Boskovic, Zagreb). pp 309-12 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25-28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.

See CONF-670981.

The spectrum correction factors for $\beta^+$ and electron-capture decay of $^{178}$Ta were calculated. The 797-keV transition was analyzed for finite size, screening, and nuclear structure effects on the K/$\beta^+$ ratio. The K/$\beta^+$ ratio was calculated using matrix elements determined for the Nilsson model. (J.W.R.)

**31049** $P_4$ TERM IN THE PERTURBED $\beta-\gamma$ DIRECTIONAL CORRELATION OF $^{166}$Ho IN $Ho_2O_3$. Grenacs, L.; Lehmann, J.

(Univ., Louvain, Belg.). pp 263-7 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25-28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.

See CONF-670981.

In perturbed $\beta-\gamma$ directional correlations involving first-forbidden transitions where the attenuation is dependent on the recoil energy, a $P_4$ term is expected. This is due to the weighted integration on the $\beta-\nu$ angle in the correlation coefficients. Experimental results are presented which show the presence of a $P_4$ term in the directional correlation of $^{166}$Ho in a $Ho_2O_3$ source. (J.W.R.)

**31050** BETA DECAY OF $^{176m}$Lu. Deutsch, J. P.; Grenacs, L.; Lehmann, J.; Lipnik, P. (Univ., Louvain, Belg.). pp 233-45 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25-28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.

See CONF-670981.

Beta-spectrum measurements were performed for $^{176m}$Lu, both on the total spectrum and on the branch leading to the 88.3 keV level of $^{176}$Hf. The intensity of this branch was found to be 57 ± 2%. Beta-$\gamma$ directional correlation measurements were also performed. Nuclear matrix elements were extracted. The results establish the $1^-$ assignment for $^{176m}$Lu. (J.W.R.)

**31051** BETA-GAMMA DIRECTIONAL CORRELATION MEASUREMENTS IN THE DECAY OF $^{144}$Ce AND $^{166}$Dy. Siddique, D.; Deutsch, J. P.; Lipnik, P. (Univ., Louvain, Belg.). pp 253-7 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25-28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.

See CONF-670981.

Beta-gamma directional correlation measurements were performed on the $\beta$ decay of $^{144}$Ce and $^{166}$Dy. The results, in conjunction with other measurements, were used to determine the nuclear matrix elements. These were compared with predictions of the CVC theory of weak interactions and with those of nuclear models. (J.W.R.)

## Nuclear Theory

*Refer also to abstracts 28725, 28772, 30296, 30661, 30705, 30722, 30937, 30952, 30954, 30969-30972, and 30991.*

**31052** (BMwF-FBK-68-50) STRUCTURE ANALYSIS OF NUCLEAR PHYSICS EXPERIMENTS AS A BASIS FOR ON-LINE CONTROL BY A DIGITAL COMPUTER. Frevert, L. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Dec. 1968. 60p. (In German). Dep.

The basic lines along which experiments of actual interest at the Nuclear Physics Department of the Hahn-Meitner-Institute for Nuclear Research, Berlin, are being run are described. The possibilities of improving these experiments by means of on-line data processing and on-line control by a digital computer are discussed. On the basic experimental design derived from such an analysis a proposal for a software system is being developed. Further work projected to be done in continuation of the structure analysis of nuclear physics experiments is outlined. (auth)

**31053** (CSIR-282) EVAP: A COMPUTER PROGRAMME FOR THE CALCULATION OF ANGULAR MOMENTUM DISTRIBUTIONS IN NEUTRON-EVAPORATION REACTIONS. Mills, S. J. (Council for Scientific and Industrial Research, Pretoria (South Africa). National Physical Research Lab.). Feb. 1968. 36p. Dep.

A statistical-model program for the calculation of the relative populations of angular momentum states populated in neutron-evaporation reactions is described. A FORTRAN IV(G) listing of the program is given in an appendix. (auth)

**31054** (IN-1222) LOW ENERGY NEUTRON SPECTROSCOPY. MEASUREMENTS ON FISSILE NUCLIDES. Moore, M. S. (Idaho Nuclear Corp., Idaho Falls). Jan. 1969. 230p. Dep. CFSTI.

Fission of nuclei by resonance-energy neutrons is reviewed, through 1967, in the context of the channel theory of A. Bohr. Recent developments in the techniques of measuring cross sections of fissile nuclides are discussed. The data are examined in the light of giving evidence on spin dependencies of fission widths, mass distributions, fragment kinetic energies, and other fission properties. It is concluded that not only do these properties depend on spin, but they most probably also depend on the quantum characteristics of the fission saddle-point. (auth)

**31055** (ITF-69-10) GROUND-STATE WAVE FUNCTION IN THE METHOD OF STRONG COUPLING. Antonchenko, V. Ya.; Simenog, I. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 20p. (In Russian). Dep.

A suggestion of improving the evaluation of the quadratic mean radius by taking into account the asymptotic properties of the wave function is considered. The mentioned above evaluation in approximation of two-particle strong coupling is dissatisfactory. The approximated wave function as well as form factors of $ch^{-2}$ and $e^{-x^2}$ potentials are analyzed. (auth)

**31056** (JINR-P4-4376) MESON THEORY OF NUCLEAR FORCES. Pak Ben Gir (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 11p. (In Russian). Dep.

Matrix elements for the spin-momentum term of the nucleon-nucleon potential for two-nucleon system states were obtained. In the one-boson-exchange model the connection between the nucleon-nucleon and nucleon-antinucleon interaction was considered for the cases of exchange of mesons having different symmetry. (auth)

**31057** (KFK-835) THE INFLUENCE OF THE SHELL EFFECT ON THE KINETIC ENERGY AND THE EXCITATION ENERGY OF FISSION FRAGMENTS. Dickmann, F.; Dietrich, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Sept. 1968. 57p. (In German). Dep.

In order to derive the nuclear model for the fission point, the nucleus in the fission configuration is described by Nilsson potentials with pair force as residual interaction. In order to consider at the same time the saturation property of the nuclear matter, the shell model description according to the Strutinskii proposal is combined with the drop model. The model parameters are derived. The shell effects in the deformation energy of an isolated nucleus and with two nuclei at rest are calculated according to this model. The comparison with experimental results and other calculations gives satisfactory agreement. (J.S.R.)

**31058** (MIT-2098-528) THEORY OF ANALOG RESONANCES. Kerman, A. K. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Mar. 1969. Contract AT(30-1)-2098. 36p. (CONF-690310-5). Dep. CFSTI.

From Conference on Isobaric Spin, Pacific Grove, Calif.

The use of the analog resonance phenomena to probe the parent wave functions and also to probe the final-state wave function is discussed. One can carry out this program to the extent that the matrix elements of the two-body Coulomb force are really very small compared to the matrix elements of the one-body average Coulomb field, and the coupling of the analog state to the continuum through the intermediary of the compound nucleus can be studied by a random-phase argument, or if not, can be studied by making some more precise statements about the compound nucleus modes themselves. Therefore the conclusion (always subject to further study of the small effects) is that one should be able to accurately determine spectroscopic factors (detailed wave functions in general) for analog states using a microscopic theory. This eliminates some of the over-simplifications of the macroscopic theories. But the data analysis should then always be given in terms of escape amplitudes and total widths, not partially theoretical quantities. (auth)

**31059** (NP-17845) ANNUAL REPORT, 1967. (Stichting voor Fundamenteel Onderzoek der Materie, Utrecht. Stichting Instituut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)). 183p. (In Dutch). Dep.

The structure and financing of the Foundation for Fundamental Research on Matter and the Foundation for Nuclear Physics Research are described. The research on nuclear physics, mass separation and analysis, metals, molecular physics, solid state physics, thermonuclear reactions, and high energy physics is briefly outlined. Bibliographic data are given for the published works in each division. (C.E.S.)

**31060** APPROXIMATION OF THE OFF-ENERGY-SHELL PART OF THE t MATRIX. Gomez-Gimeno, F. (Institut du Radium, Orsay, France). Nucl. Phys., A129: 615-24(1969). (In French).

The off-shell amplitudes for identical particle scattering are exactly calculated by numerical integration of the Schrödinger equation under the assumption that the two-particle interaction is given by a central parity-dependent Yukawa potential with a hard core. By comparison with these exact values it is shown that the Stern and Chamberlain approximation method previously used by Benoist-Gueutal and the writer enables one to obtain the real part of the off-shell amplitudes with a good accuracy. Yet, the unitarity defect of the method does not ensure the correctness of the imaginary-part values. Then we complete the t-matrix

by calculating the imaginary part which is the solution of unitarity relation. One can see easily that the accuracy is the same in either the real or the imaginary part. This process gives a good idea of our goal, which is the systematic approach to the off-shell part by the on-shell part of the t-matrix. (auth)

**31061** NUCLEAR CURVATURE ENERGY FROM THRESHOLD ENERGIES. von Groote, H. (Univ., Frankfurt am Main); Hilf, E. Nucl. Phys., A129: 513-34(1969).

Theoretical studies in the shell model have led to the conclusion that the shape dependence of the liquid-drop part of the semi-empirical mass formula of the Weizsäcker–Bethe type should contain terms proportional to the volume, the surface, and the mean-total curvature of the surface of the drop, respectively. Now the surface tension $\beta_c$ and the curvature tension $\gamma_c$ are fitted to the experimentally known fission barriers of 35 nuclei. Furthermore, the parameters of the liquid-drop part of the mass formula are roughly fitted to the ground-state masses of about 600 beta-stable nuclei. For the elementary radius $r_c$, the value 1.123 fm (determined by Elton) is used. As a result, $\gamma_c$ should be in the range 6 to 8 MeV, with the value 6.8 MeV being the most probable, thus $\beta_c$ = 17.85 MeV. For sufficiently large values of the curvature tension (e.g., $\gamma_c$ = 13.4 MeV), a small double-hump fission barrier occurs in the region of Ra. (auth)

**31062** CLUSTER STRUCTURE OF ALPHA-PARTICLE NUCLEI. Abul-Magd, A. Y. (Cairo Univ.). Nucl. Phys., A129: 610-14(1969).

The lower bounds to the ground state energy of a system of N alpha particles interacting via a potential determined by alpha–alpha scattering experiments is compared with the energies of nuclei with 2N protons and 2N neutrons. It is concluded that the ground state of doubly even nuclei with an equal number of protons and neutrons heavier than $^{20}$Ne as well as the first excited $0^+$ states of $^{12}$C and $^{20}$Ne can in principle be represented as systems of rigid and structureless alpha particles. The amount of the distortion of the alpha particles inside these nuclei is estimated by comparing the neutron separation energy from the nucleus and from the alpha particles. (auth)

**31063** ELECTRON CAPTURE AND INTERNAL CONVERSION. Daniel, H. (Technische Hochschule, Munich). Z. Phys., 223: 150-1(1969).

$L_I$/K electron capture ratios are expressed in terms of internal conversion coefficients. (auth)

**31064** TWO-NUCLEON TRANSFER REACTIONS AND PARITY MIXING IN SINGLE-PARTICLE ORBITALS. Boffi, S.; Pacati, F. D. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy). Nucl. Phys., A129: 673-86(1969).

Two-nucleon transfer reactions are proposed in order to reach a decisive conclusion about the hypothesis of parity mixing in nuclear single-particle wave functions. General formulas for the differential cross sections and new selection rules are established. The theory is applied to $^6$Li(p,$^3$He)$^4$He and $^{12}$C($^3$He,p)$^{14}$N reactions. In the latter reaction there is some indication in favor of parity mixing in the final ground-state transition. A (p,pd) reaction is also studied in the case of a $^6$Li target, for comparison: also here, as in $^6$Li(p,$^3$He)$^4$He, similar results are obtained both with parity mixing and without. (auth)

**31065** COUPLING COEFFICIENTS AND MATRIX ELEMENTS OF ARBITRARY TENSORS IN THE ELLIOTT PROJECTED ANGULAR MOMENTUM BASIS. Draayer, J. P.; Williams, S. A. (Ames Lab., Iowa). Nucl. Phys., A129: 647-65(1969).

An explicit expression for the transformation brackets between the basis for an arbitrary irreducible representation of U(3) labeled in the U(3) ⊃ R(3) scheme introduced by Elliott and the Gel'fand U(3) ⊃ U(2) ⊗ U(1) scheme is obtained. The results are applied in deriving an expression for both the U(3) ⊃ R(3) coupling coefficients and projected tensor matrix elements. (auth)

**31066** MODIFIED TAMM–DANCOFF APPROXIMATION FOR NUCLEI WITH UNFILLED NEUTRON AND PROTON SHELLS. Raj, Ram; Rustgi, M. L. (State Univ. of New York, Buffalo). Phys. Rev., 178: 1556-64(Feb. 20, 1969).

The modified Tamm–Dancoff approximation, proposed earlier, is extended to describe the states of both even and odd nuclei having neutrons and protons belonging to well-separated shells, and take into account the mixing between quasiparticle states obtained by limiting the excitations to a total of four quasiparticles. Employing the good set of quasiparticle basis states classified according to the well-known seniority scheme, necessary expressions for the calculation of matrix elements and transition rates are derived for both even and odd nuclei. (auth)

**31067** RELATIVISTIC CORRECTIONS IN THE THEORY OF K-ELECTRON EJECTION DURING K CAPTURE. Intemann, R. L. (Temple Univ., Philadelphia). Phys. Rev., 178: 1543-51(Feb. 20, 1969).

The momentum spectrum of the K electrons ejected during allowed K-capture decay is calculated for the case in which there is no competing positron emission. It is shown that certain relativistic effects, associated with the spin of the electron, are important in determining the ejected-electron spectrum, even at low energies. To take these effects into account, the electronic states are described by the solutions of an approximate Dirac Hamiltonian developed by Biedenharn and Swamy. Preliminary to the calculation, both the eigenfunctions and Green's function of this Hamiltonian are discussed. The results of the calculation differ appreciably from previous nonrelativistic calculations. Contrary to these previous theories, the theory presented here is shown to be in good agreement with recent experimental observations. (auth)

**31068** SEPARABLE-POTENTIAL MODELS OF THE NUCLEON–NUCLEON INTERACTION. Mongan, Thomas R. (Univ. of California, Berkeley). Phys. Rev., 178: 1597-1611(Feb. 20, 1969).

Four different separable-potential models of the nucleon-nucleon interaction are presented which fit both the low-energy data and the MacGregor–Arndt–Wright phase parameters for partial waves through J = 4 in the energy range 0 to 400 MeV. The partial-wave scattering amplitudes resulting from these potentials have driving singularities at real negative values of the complex energy variable, and the appropriate amplitudes contain the deuteron pole and the singlet antibound-state pole at the correct energies. The present work extends and completes the results of an earlier paper. (auth)

**31069** CONSERVATION OF THE NUMBER OF PARTICLES IN THE TAMM–DANCOFF APPROXIMATION FOR SPHERICAL SUPERCONDUCTOR NUCLEI. Ottaviani, P. L. (Comitato Nazionale per l'Energia Nucleare, Bologna); Savoia, M. Phys. Rev., 178: 1594-6(Feb. 20, 1969).

A modified Tamm–Dancoff approximation for spherical superconductor nuclei is formulated. The approximation consists in diagonalizing the nuclear Hamiltonian in the space spanned by the components of zero- and two-quasiparticle excitations corresponding to a fixed particle number ("projected states"). Thus, spurious states arising from the Bogoliubov–Valatin canonical transformation, which are present in the usual Tamm–Dancoff approximation, are completely eliminated. Matrix elements between "projected states" are evaluated by the Bayman projection method of the generating functions. The model is applied to the calculation of the low-lying excited states of the tin isotope with A = 116, and the results are compared with the corresponding ones obtained in the Tamm–Dancoff approximation. The conclusion is that the effect of the particle-number nonconservation is important mainly for the energies of the highest levels. This becomes particularly clear for the J = 0 case. (auth)

**31070** HARD-CORE POTENTIALS AND THE THREE-BODY PROBLEM. Fuda, Michael G. (State Univ. of New York, Buffalo). Phys. Rev., 178: 1682-8(Feb. 20, 1969).

A method is presented for treating hard-core potentials within the framework of the Lippmann–Schwinger scattering-theory formalism. Using the method, a procedure is developed for constructing separable expansions of the t matrix arising from potentials containing hard cores. Such expansions reduce the Faddeev equations to equations in one continuous variable. The rate of convergence of the expansion is illustrated by using it in a calculation of the binding energy of a system of three identical spinless particles interacting via square-well potentials with hard cores. (auth)

**31071** THEORY OF (a,xn) REACTIONS. Sperber, Daniel (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 178: 1688-94(Feb. 20, 1969).

A new method for the study of (a,xn) reactions is presented (a = n, p, $\alpha$, $\gamma$, HI). The method is applicable to reactions in which first a compound nucleus is created and later x neutrons are evaporated. The method allows the calculation of excitation functions for the emission of a specified number of neutrons, average neutron energies, and neutron spectra. The equations governing a succession of neutron emissions are derived from first principles. The effect of $\gamma$ decay is incorporated. The effect of spin on decay rates is treated rigorously. The theory is used to calculate the excitation function for the reactions $^{109}$Ag($\alpha$,n)$^{112m}$In, $^{109}$Ag($\alpha$,n)$^{112g}$In, and $^{109}$Ag($\alpha$,2n)$^{111}$In. The comparison between measured and calculated values is discussed. (auth)

**31072** OPTIMIZATION OF NUCLEAR RESONANCE REACTION CALCULATIONS. Lane, A. M. (Univ. of Colorado, Boulder); Robson, D. Phys. Rev., 178: 1715-24(Feb. 20, 1969).

An important current problem is to find the most economical and physically significant method of calculating nuclear resonant cross sections. Tobocman and co-workers have discussed an R-matrix type of approach in which the wave function is restricted to be a linear combination of a given finite set of states associated with the resonances. That work presented several different formulas for calculation, leaving uncertainty as to which, if any, was the best one. This paper gives systematic reasons why one specific formula should be more accurate than all others. This result applies to any set of states, and is not restricted to the special set used in the previous work. A curious incidental result is that the variational principle for scattering problems introduced by Kohn fails to give a stationary result when applied to the present problem. (auth)

**31073** REALISTIC NUCLEAR SINGLE-PARTICLE HAMILTONIANS AND THE PROTON SHELL 114. Meldner, Heiner (Univ. of California, Berkeley). Phys. Rev., 178: 1815-26 (Feb. 20, 1969).

A simple self-consistent single-particle equation is investigated and compared with similar attempts. The proposed model is designed to be particularly suitable for the calculation of (adiabatic) fission processes. The kernel of this integrodifferential equation has a structure that allows satisfactory reproduction, with one constant set of five physical parameters, of charge density distributions including isotope shifts, 1s proton levels as measured in (e,e'p) scattering, total binding energies or nuclear mass defects, and the shell-model spin assignments and mass structure throughout the periodic table. Hence, it seems that all future work in this direction has to confirm quantitatively the essential features determined here, particularly the nonlocality and rearrangement effects. Rearrangement energies appear explicitly, since the present model, like self-consistent fields of appropriate many-body formalisms, yields different eigenvalue spectra and mass defects for different occupation functions. The partial derivative $\partial E/\partial Z$ of the total binding energy (mass) changes considerably at the proton number Z = 114 when the present Hamiltonian is used for superheavy nuclei. This confirms an earlier suggestion made by this author on the basis of a gap in the proton eigenvalue spectrum at Z = 114. The present calculations show that this shell effect becomes insignificant for isotopes too far from the extrapolated $\beta$ stability line, in particular for $N \lesssim 172$. (auth)

**31074** $0^- \rightarrow 0^+$ NUCLEAR BETA TRANSITIONS. Krmpotic, F. (Facultad de Ciencias Exactas, La Plata); Tadic, D. Phys. Rev., 178: 1804-14(Feb. 20, 1969).

The nonrelativistic $\beta$-decay interactions are classified into five different types, for which the appropriate theoretical expressions for the spectrum-shape factor and the longitudinal polarization are given. Detailed comparison with previous work is included. Two experiments on $^{144}$Pr and one on $^{166}$Ho are analyzed with each of the defined approximations. A new upper limit on the pseudoscalar contribution is determined. Existing experimental results are, however, not in good enough mutual agreement to support any far-reaching deductions about the induced pseudotensor or pseudoscalar coupling. The extraction of useful and trustworthy information about the weak interactions from these experiments will require both the accurate measurement of the spectrum shape factors and longitudinal polarizations, and reliable theoretical limits on the square of the relevant nuclear matrix element $\mathfrak{M}$. (auth)

**31075** PHENOMENOLOGICAL ANALYSIS OF GROUND-STATE BANDS IN EVEN-EVEN NUCLEI. Mariscotti, M. A. J.; Scharff-Goldhaber, Gertrude; Buck, Brian (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 178: 1864-87(Feb. 20, 1969).

A variable-moment-of-inertia (VMI) model is proposed which permits an excellent fit of level energies of ground-state bands in even-even nuclei. In this model the energy of a level with angular momentum I is given by the sum of a potential energy term $\propto (\mathcal{I}_1 - \mathcal{I}_0)^2$ (where $\mathcal{I}_0$ is the ground-state moment of inertia) and a rotational energy term $\hbar^2 I(I+1)/2\mathcal{I}_1$. It is required that the equilibrium condition $\partial E/\partial \mathcal{I} = 0$ be satisfied for each state. Each nucleus is described by two adjustable parameters, $\mathcal{I}_0$ and $\sigma$ (the softness parameter), which are determined by a least-squares fit of all known levels. The calculated level energies and moments of inertia $\mathcal{I}_1$, $\mathcal{I}_0$, and $\sigma$ are tabulated for 88 bands, ranging from Pd to Pt and from Th to Cm. Projections of three-dimensional arrays of $\mathcal{I}_0$ and $\sigma$ on the (N,Z) plane are shown. These parameters are found to vary smoothly as functions of N and Z. Breaks occur at N = 98, 104, and 108. The osmium nuclei show a pronounced maximum for $\mathcal{I}_0$ and an equally pronounced minimum for $\sigma$ at 108 neutrons. In Pt, $\mathcal{I}_0$ decreases steeply to 110 neutrons and then more slowly, while $\sigma$ increases correspondingly. The stable Pt nuclei with A = 190, 192, and 194 still possess appreciable moments of inertia and large but "finite" softness parameters. Hence they may be characterized as "pseudospherical." For nuclei exhibiting a near-harmonic level pattern (like $^{130}$Xe, $^{150}$Sm, and other neutron-deficient rare-earth isotopes), $\mathcal{I}_0$ becomes exceedingly small, but already for the 2+ state $\mathcal{I}$ is several orders of magnitude larger. The parameters of some K = 2 bands in even-even nuclei and of bands found in odd-odd nuclei are related to those of appropriate ground-state bands in even-even nuclei. Evidence for a rotational band in $^{194}$Ir is deduced from recently published experimental results. A plot of $E_4/E_2$ versus A, presented for the discussion of the region of validity of the model, namely, $2.23 \leq E_4/E_2 < 3.33$, reveals new regularities. The empirical "Mallmann curves" ($E_I/E_2$ plotted versus $E_4/E_2$) are deduced from the VMI model within its region of validity. Graphs are presented which allow the determination of $E_I$ (for $I \leq 16$) and of $\sigma$ and $\mathcal{I}_0$ for each even-even nucleus for which the first 2+ and 4+ states are known. The model suggested by Harris, which includes the next-higher-order correction of the cranking model, is shown to be mathematically equivalent to the VMI model. The recently discovered appreciable quadrupole moments of 2+ states of "spherical nuclei" are compatible with the moments of inertia of these states given by the VMI model. The relation between B(E2) $(2' \rightarrow 2)$ B(E2) $(2 \rightarrow 0)$ and $E_4/E_2$ is explored. (auth)

**31076** PHYSICAL INFORMATION NEEDED TO SOLVE THE THREE-NUCLEON PROBLEM. Noyes, H. Pierre (Stanford Linear Accelerator Center, Calif.). Progr. Nucl. Phys., 10: 355-80(1969).

The three-nucleon problem is formulated in terms of the two-nucleon interaction. Developments in nuclear theory and experimental techniques which may permit the solution of the problem are described. Further experimental and theoretical knowledge of two-nucleon forces which are needed are discussed. (86 references). (J.W.R.)

**31077** QUASISPIN FORMALISM. Ichimura, Munetake (Nihon Univ., Tokyo). Progr. Nucl. Phys., 10: 307-53(1969).

The quasispin formalism for treating pairing correlations in nuclear theory is described. The technique is formulated in the seniority-reduced isospin scheme. The supermultiplet scheme and five-dimensional quasispin are also examined. The application of the general theory of quasispin to other areas of physics is also discussed. (50 references) (J.W.R.)

**31078** STRUCTURE OF THE GROUND AND EXCITED STATES OF DEFORMED NUCLEI. Solovev, V. G. (Joint Inst. for Nuclear Research Dubna, USSR). Progr. Nucl. Phys., 10: 239-71(1969).

A number of problems concerning the microscopic approach in nuclear theory and its application to the study of the structure of deformed nuclei are discussed. The main formulas of the theory of pairing correlations and of the method of approximate second quantization are reviewed. The interaction of quasiparticles with phonons is examined in detail. (48 references) (J.W.R.)

**31079** EXCITATION OF SIMPLE PARTICLE-HOLE CONFIGURATIONS IN THE RESIDUAL NUCLEUS. Bloch, C. (CEN de Saclay, Gif-sur-Yvette, France); Cindro, N.; Harar, S. Progr. Nucl. Phys., 10: 77-115(1969).

The theory of particle-hole excitations in nuclei by inelastic scattering and nucleon transfer reactions is reviewed. The experimental evidence for 1p–1h states is also reviewed. The theory of 2p–1h and more complicated configurations is also discussed. (57 references) (J.W.R.)

**31080** PROGRESS IN NUCLEAR PHYSICS. VOLUME 10. Brink, D. M.; Mulvey, J. H. (eds.). Oxford, Pergamon Press Ltd., 1969. 394p. $19.00.

Separate abstracts were prepared for 5 of the 8 papers included. The remaining 3 papers have previously appeared in NSA. (J.W.R.)

*For abstracts of individual papers see: 30952 and 31076–31079.*

**31081** RECHENUEBUNGEN ZUR KERNTECHNIK. KERNPHYSIKALISCHE GRUNDLAGEN. (Nuclear Engineering Problems and Calculations. Basic Nuclear Physics). Mardus, Guenter. Buchreihe der Atomkernenergie, Band 5. Munich, Verlag Karl Thiemig KG, 1968. 164p.

The nuclear engineering problems and calculations presented are designed for the engineering student and for the practicing engineer to introduce him to basic nuclear physics. Calculations and problems on atomic shell, atomic nucleus, radioactivity, and nuclear reactions are presented. (J.S.R.)

**31082** NUCLEAR CHARGE DENSITY DISTRIBUTIONS. Hofstadter, Robert (Stanford Univ., Calif.). Proc. Robert A. Welch Found. Conf. Chem. Res., 11: 31-74(1968).

From 11th Robert A. Welch Foundation Conference on Chemical Research, Radiation, and the Structure of Matter, Houston, Tex. See CONF-671219.

Studies on nuclear charge density distributions performed with electron scattering experiments and $\mu$-mesic atom spectra are surveyed. Some nuclear structure properties that may be obtained from these experiments are described. The current states of research on charge density distributions are outlined. (J.W.R.)

**31083** USE OF THE K MATRIX IN NUCLEAR REACTION THEORIES. Tobocman, W.; Nagarajan, M. A. (Case Western Reserve Univ., Cleveland). Phys. Rev., 179: 1230-2(Mar. 20, 1969).

In the original article the formal solution to the integral equation for the reactance operator K was found and shown to differ from the generally accepted form. The incorrect expression for K was used in projection-operator formalisms for nuclear reactions by Bloch and Gillet (BG) and by MacDonald and Mekjian (MM). These scattering formalisms were applied to a simple soluble model. The discrepancy arising from the use of the incorrect K was found to have no observable consequences for the MM treatment. No explicit expression was found for the discrepancy between the BG prediction and the exact result for the simple scattering model. The discrepancy of the BG formalism for the simple scattering model is found. This discrepancy is found to be nonzero at all energies. In the neighborhood of certain energies for zero-range potential scattering, the BG discrepancy can become very large. In addition, by examining the explicit expressions for the K matrix for zero-range potential scattering, a simple interpretation is given the difference between the correct form of the reactance operator and the generally accepted incorrect form. (auth)

**31084** UNIFIED NUCLEAR MODEL FOR THE GENERATION OF NUCLEAR DATA. Yost, K. J.; Pitkanen, P. H.; Fu, C. Y. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 36: 189-201 (May 1969).

A nuclear model pertinent to the generation of certain classes of nuclear data is described. The analysis is structured so as to minimize difficulties in its numerical implementation. The model involves the simultaneous treatment of particle excitations in a deformed potential well, together with rotational and vibrational collective excitations. Details of certain aspects of the theory are presented with comparisons of calculated and measured level structures for several nuclei of interest in shielding technology. (auth)

**31085** CORRECTIONS TO THE HARTREE-FOCK APPROXIMATION FOR HOMOGENEOUS NUCLEAR MATTER. MacKenzie, James J. (Argonne National Lab., Ill.). Phys. Rev., 179: 1002-10(Mar. 20, 1969).

The convergence of a modified Goldstone linked-cluster expansion for the binding energy of nuclear matter is considered for the Tabakin and Elliott-Flowers potentials. It is argued that a comparison of the first-order term with the second-order term cannot give a direct indication of the convergence of the series. Calculations have therefore been performed to evaluate all terms through third order. For the Elliott-Flowers potential the third-order terms amount to 26% of the second-order contribution; for the Tabakin potential they are less than about 10%. (auth)

**31086** IDENTITY FOR THE TOTAL CROSS SECTION IN AN INFLASTIC COLLISION. Bransden, B. H.; Reading, J. F. (Univ. of Washington, Seattle). Phys. Rev., 179: 982-3(Mar. 20, 1969).

A mathematical identity is derived, expressing the total cross section for producing an excited state in terms of the imaginary part of an integral involving the wave function. (auth)

**31087** SEPARABLE APPROXIMATIONS TO THE t MATRIX. Levinger, J. S.; Lu, A. H.; Stagat, R. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 179: 926-39(Mar. 20, 1969).

Reiner's comparison of several separable approximations for the off-energy-shell t-matrix elements t(p,k;s) with those for a local, central square-well potential for negative energy s is extended. Other separable potentials besides the Noyes approximation considered by Reiner are treated, namely, the Weinberg series terminated at one, two, or three terms, and the unitary-pole approximation. A larger range of momenta and energy than treated by Reiner is considered. The unitary-pole approximation is in general the best of the four one-term separable approximations used. The off-energy-shell values of t(p,k;s) have an error of less than 5% of the value of t(0,0;0). The Weinberg series converges rapidly, two terms giving in general an error of less than 1% of t(0,0;0). Phase shifts for positive energy and the effective-range parameters were compared. By definition, the Noyes prescription gives the exact value. The unitary-pole approximation gives good results, and again the two-term Weinberg series is very satisfactory. Problems arising in the more realistic case (for the two-nucleon potential) from the use of other shapes for the attractive potential, of a strong short-range repulsion, and of tensor forces are discussed qualitatively. (auth)

**31088** CRITERIA FOR SLATER DETERMINANTS AND QUASIPARTICLE VACUUM STATES. Navon, A. (McGill Univ., Montreal). J. Math. Phys. (N. Y.), 10: 821-6(May 1969).

New criteria characterizing Slater determinants and quasiparticle vacuum states are obtained. These criteria are expressed as quadratic homogeneous equations in the coefficients of the development of the trial wavefunction in a basis of Slater determinants. A redefinition of quasiparticle vacuum states permits the introduction of quasiparticle transformations which are more general than the generalized Bogoliubov transformations. (auth)

**31089** CORRECTION OF SCATTERED-ELECTRON SPECTRA FOR RADIATIVE EFFECTS. Crannell, H. (Stanford Univ., Calif.). Nucl. Instrum. Methods, 71: 208-14(1969).

The distortions caused by the effects of nuclear and thick-target bremsstrahlung on the spectrum of scattered electrons obscure the actual elastic and inelastic cross sections. A method whereby the spectrum can be systematically corrected for these effects is presented. The method uses previous theoretical calculations of the radiative probabilities and employs an iterative technique for step by step correction of the spectrum. Uncertainties due to statistical errors in the measurement propagate through such a calculation. A formulation in which the uncertainties can be explicitly calculated is presented. Corrections to the calculations due to effects such as the change in cross section with change in electron energy are discussed. Special problems associated with the applications of digital computers to this technique are described. (auth)

**31090** A UNIQUENESS PRINCIPLE AND THE HILBERT INVARIANT INTEGRAL IN GENERAL FIELD THEORY. Garrity, Michael Kelly. Tempe, Ariz., Arizona State Univ., 1969. 96p. Thesis.

The mass energy density concept is discussed in relation to an arbitrary field and the development of variational and uniqueness principles for a general field principle. The principle of uniqueness is developed and mass is introduced as an integrating factor which restores uniqueness in a nontrivial dynamical case. An equivalence is shown to Newtonian dynamics of conservative fields. A natural extension to electrodynamics is made by allowing the field to become an inhomogeneity in the equations for mass energy. This, however, is done at the expense of uniqueness. A more general metric, the Fermi Walker metric, is considered and a corresponding mass energy density is determined from the uniqueness condition. The principle of uniqueness is extended to the general field by means of the Weierstrass E function and the Hilbert invariant integral. The mass energy density becomes the field parameter of the extremals upon which the Hilbert invariant integral is based. The previous development is applied to the problem of electromagnetic lens design. The result for a thick magnetic lens is a stability condition on the field for a short focal length. The main advantage of this formulation is its generality and its correlation with experimental data in the form of trajectories in spacetime. The main disadvantage is the lack of a systematic approach to the choice of extremal and field parameter form. (Diss. Abstr.)

**31091** BETA-GAMMA CORRELATION MEASUREMENTS. Deutsch, J. (Univ., Louvain, Belg.). pp 177-87 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25-28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.

See CONF-670981.

The use of $\beta-\gamma$ correlation measurements in studying nuclear structure, weak and strong interactions, electromagnetic interactions, and solid-state effects is described. Calibration problems and source-scattering effects in measuring $\beta-\gamma$ correlations are discussed. (52 references) (J.W.R.)

**31092** NUCLEAR STRUCTURE AND NUCLEAR $\beta$ DECAY. Damgard, J. (Univ. of Copenhagen). pp 151-76 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25-28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.

See CONF-670981.

The use of nuclear beta decays in the study of nuclear structure

is discussed. The theory of allowed Fermi and Gamow–Teller decays and forbidden decays is reviewed. (J.W.R.)

**31093** SHAPES OF $\beta$-RAY SPECTRA. Daniel, H. (CERN, Geneva. Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 113-49 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25-28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.
See CONF-670981.

The formulations for the shapes of the spectra in allowed and forbidden beta decay are described. Experimental methods and results on allowed and forbidden decays are surveyed. Time-reversal invariance, the pseudoscalar interacting vector and axial vector currents, and the properties of the neutrino are discussed in connection to beta decay. (J.W.R.)

**31094** RADIATIVE CORRECTIONS IN WEAK INTERACTIONS. Kaellen, G. (Univ. of Lund, Sweden). pp 63-90 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25–28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.
See CONF-670981.

Plausibility arguments are presented in support of a method for the calculation of radiative corrections in nuclear beta decay. Some other methods currently in use are discussed. (J.W.R.)

**31095** NUCLEAR BETA DECAY AND WEAK INTERACTIONS. Tadic, D. (Inst. Ruder Boskovic, Zagreb). pp 25-62 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25–28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.
See CONF-670981.

Some problems in the theory of weak interactions of elementary particles are discussed and the relationship of weak interactions to nuclear beta decay is outlined. (87 references) (J.W.R.)

**31096** INTRODUCTORY LECTURE ON BETA DECAY. Alaga, G. (Inst. Ruder Boskovic, Zagreb). pp 1-24 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25–28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.
See CONF-670981.

The theory of beta decay is reviewed. The current status of experimentally determined properties of beta decay is summarized. (J.W.R.)

**31097** ANALYSIS OF UNIQUE BETA TRANSITIONS. Eman, B. (Inst. Ruder Boskovic, Zagreb. Univ. of Zagreb); Krmpotic, F.; Tadic, D.; Nielsen, A. pp 295-300 of Symposium on Nuclear Beta Decay and Weak Interactions, Zagreb, Yugoslavia, September 25–28, 1967. Eman, B.; Tadic, D. (eds.). Zagreb, Institute Ruder Boskovic, 1967.
See CONF-670981.

In order to explain deviations from the normal shape factor in some unique $\beta$ decays, an exhaustive analysis of the spectrum shape factors for unique $\beta$ transitions was performed. An interaction Hamiltonian was constructed which contained lepton covariants and axial vector, vector, induced pseudoscalar, and induced tensor coupling constants. A shape factor was obtained which fits the general trend of experimental data. (J.W.R.)

# REACTOR TECHNOLOGY

## Commercial Power Reactors

*Refer also to abstracts 28774–28780, 28943, 28944, 28981, 29016–29019, 29126, 29128, 29141, and 29978–29981.*

**31098** (AECL-3114) URANIUM USE IN CANDU REACTORS: REVIEW AND PROSPECT. Runnalls, O. J. C. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1969. 16p. (CONF-690412-1). Dep. CFSTI. CAN $0.50.

From 71st Annual General Meeting of the Canadian Institute of Mining and Metallurgy, Montreal, Canada.

A co-operative government-industry development program launched in the late 1950's has generated in Canadian industry the capability to produce high quality uranium oxide fuel bundles at all-inclusive prices of less than $50 per kg U. The direct consequence is that fuel cycle costs in heavy-water-moderated CANDU power reactors are the lowest of any reactor type now in operation. Even in competition with fast breeder reactors the CANDU systems are likely to retain the lowest fuelling costs for years to come. The Canadian requirements for sintered $UO_2$ pellets will grow by nearly ten-fold to some 1000 tonnes per year during the 1970's. Within that period, however, several alternative fuel cycles may offer stiff economic competition for natural $UO_2$ once-through fuel. These include the "valubreeder" cycle which is based on a mixture of uranium and thorium; natural uranium silicide, $U_3Si$; and plutonium recycle. All three alternatives become more attractive relative to natural $UO_2$ as uranium prices rise. 16 references. (auth)

**31099** (APDA-233) REPORT ON THE FUEL MELTING INCIDENT IN THE ENRICO FERMI ATOMIC POWER PLANT ON OCTOBER 5, 1966. (Atomic Power Development Associates, Inc., Detroit, Mich.). Dec. 15, 1968. 135p.

For Power Reactor Development Co., Detroit, Mich.

A very brief summary of operation of the Fermi Fast Breeder, prior to October 5, 1966, is given. Plant operation is detailed for Oct. 4 and 5; radiation detector readings are tabulated for Oct. 5 and 6. A cross section of the core shows subassembly location. Plant investigations after Oct. 5, 1966, are summarized. A failure mode analysis for the zirconium flow guide segment is given; results of analytical and experimental investigations are summarized. Plant inspections and modifications are described. Proposed re-startup plans are outlined. Appendices contain: a detailed description of the reactor, details of analytical and experimental investigations, details of post-incident destructive examination of subassemblies, and a history of important events since October 5, 1966. (M.L.S.)

**31100** (BNWL-960) EFFECTS OF SITE LOCATION ON THE CAPITAL COSTS OF NUCLEAR ELECTRIC PLANTS. Kempf, F. J.; Fletcher, J. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1969. Contract AT-(45-1)-1830. 95p. Dep. CFSTI.

Cost estimates were made for the construction of a 1000 MW(e) light water reactor nuclear power plant at the USAEC hypothetical site and at nine typical sites at various locations in the United States. Comparisons were made of the variation of costs estimated to be incurred in the construction of power plants of essentially identical design at the various sites considered, using a 1060 MW(e) BWR plant as a model for development of cost data. Because of the important effect on capital costs of methods for rejecting heat from the main steam condensers, cost comparisons were made at each site for plants utilizing different types of heat rejection systems. 33 references. (auth)

**31101** (CONF-680810) ABUNDANT NUCLEAR ENERGY. Proceedings of a Symposium held at Gatlinburg, Tennessee, August 26–29, 1968. (Oak Ridge Associated Universities, Inc., Tenn.). May 1969. 352p. Dep. CFSTI.

Eighteen papers presented at the conference and a panel discussion on the effects on university engineering programs of abundant nuclear energy are included. Separate abstracts were prepared for the 18 papers. (M.C.G.)

*For abstracts of individual papers see: 28774–28780, 28943–28945, 29978–29981, 31102, and 31249–31251.*

**31102** (CONF-680810–, pp 3-28) RATIONALE FOR LOW-COST NUCLEAR HEAT AND ELECTRICITY. Lane, James A. (Oak Ridge National Lab., Tenn.).

It is projected that the average delivered cost of electricity in the United States will decrease to 3.5 mills/kw-hr and the per capita consumption will increase to 30,000 kw-hr per annum in 2000 AD. Achieving such low-cost power will require significant improvements in generating costs, as well as reductions in transmission and distribution costs. Details of how this might be done are described. Generating costs, for example, will be reduced to about 1.5 mills/kw-hr through the development of very large (i.e., 5000-Mw(e)) high-performance breeders served by large-scale fabrication and processing plants. If the sale price of electricity is properly assigned to various types of customers as a function to the amount used by each customer, an average delivered price of 3.5 mills/kw-hr would result in a rate of 5.5 mills/kw-hr for residences and 1.5 mills/kw-hr for industries. (auth)

**31103** (CONF-681101-38) NEW TYPE OF REACTOR CONTAINMENT OF PRESTRESSED CONCRETE. Hoejgaard, E. (Allmanna Svenska Electriska A. B., Vasteras); Kaelleroe, K. E. (Armerad Betong A. B., Malmo (Sweden)); Nilsson, L. B. (Oskarshamnsverkets Kraftgrupp A. B., Stockholm (Sweden)). [1968]. 11p. Dep.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

The design, construction, and testing of the prestressed concrete containment structure for the Oskarshamn Power Reactor are described. (H.D.R.)

**31104** (CONF-690113-1) THE STARTUP OF KRB (KERNKRAFTWERK REW-BAYERNWERK, GERMANY). Christianson, R. C. (General Electric Co. [Santa Clara, Calif.] Nuclear Energy Div.). [1967]. 16p. IEEE.

From IEEE Winter Power Meeting, New York.

West Germany's first full scale nuclear power station, KRB, rated at 252 MW(e), was placed in commercial operation on April 29, 1967. The startup activities throughout the commission program, including the preoperational testing, initial loading, power testing, and the warranty run are described. (auth)

**31105** (CONF-690113-2) THERMIONICS IN FOSSIL-FUEL AND NUCLEAR CENTRAL POWER STATIONS. Engdahl, R. E.; Cassano, A. J. (Consolidated Controls Corp., Bethel, Conn.); Dowdell, R. B. (Rhode Island Univ., Kingston). [1968]. 13p. IEEE $1.00.

From IEEE Winter Power Meeting, New York.

The generation of electrical power, by all predictions, will about double every 10 years for the foreseeable future. Considering that the U. S. electrical utility industry is presently using fuel at the rate of $1.5 \times 10^{16}$ Btu/year, careful consideration must be given to methods which will result in maximum utilization of our coal and nuclear fuel reserves. This management effort is important to assure that we will have available fuel for future electrical power and also that we will minimize the dissipation of waste heat and other pollution products that can prove to be detrimental to man's environment. Thermionic topping of central power stations offers a method of achieving these goals. Thermionic topping, when applied as an addition to a 450 MW BWR plant, increases the output to 832 MW and improves the efficiency from 32 to 45 percent. Preliminary estimates show that the net power cost for this addition could be as low as $\frac{2}{3}$ of the original mills/kWh. 7 references. (auth)

**31106** (CONF-690113-4) PROBABILITY ANALYSIS OF THE USE OF NUCLEAR CAPACITY IN A HYDROELECTRIC SYSTEM. Houser, H. G. (Westinghouse Electric Corp., East Pittsburgh, Pa.). [1967]. 5p. IEEE $1.00.

From IEEE Winter Power Meeting, New York.

When nuclear generation is added to a hydro system the capacity factors of the nuclear units depend to a large extent on the random availability of the hydro energy with varying stream flows. A study of such a situation is presented. A method for estimating the most likely value of this important parameter is analyzed. (auth)

**31107** (CONF-690113-5) START-UP OF HADDAM NECK. Johnson, W. P. (Connecticut Yankee Atomic Power Co., Boston, Mass.); Beatty, D. C. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Plant Div.). Oct. 15, 1968. 7p. IEEE $1.00.

From IEEE Winter Power Meeting, New York.

Startup procedures for Connecticut Yankee Power Reactor are listed. Certification tests for licensing are described. The beginning of commercial operation is reported. (D.C.C.)

**31108** (CONF-690113-6) START-UP OF SAN ONOFRE. Ottoson, H. L. (Southern California Edison Co., Los Angeles); Hickman, H. D. (Westinghouse Electric Corp., Pittsburgh, Pa.). Feb. 14, 1969. 4p. IEEE $1.00.

From IEEE Winter Power Meeting, New York.

The start-up activities of the San Onofre Nuclear Generating

Station, Unit 1 are presented. The tests during startup reveal component design deficiencies, system design deficiencies, and discrepancies in plant operating instructions. Resolution of these deficiencies is important to the proper operation of this plant and the design of future plants. (auth)

**31109** (DOCKET-50250-12) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, [Amendment 17], Vol. 1. (Florida Power and Light Co.). May 12, 1969. 787p. (DOCKET-50251-12). Dep. CFSTI.

Final design and safety information on Turkey Point Power Reactor, Units 3 and 4 is given on the following broad topics: Introduction and Summary; Site and Environment; Reactor; Reactor Coolant System; and Structures. (M.L.S.)

**31110** (DOCKET-50250-13) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, [Amendment 17], Vol. 2. (Florida Power and Light Co.). May 12, 1969. 475p. (DOCKET-50251-13). Dep. CFSTI.

Final design and safety information is given on Turkey Point Power Reactor, Units 3 and 4 on the following broad topics: Engineered Safety Features; Instrumentation and Control; Electrical Systems; Auxiliary and Emergency Systems; and Steam and Power Conversion System. (M.L.S.)

**31111** (DOCKET-50250-14) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, [Amendment 17], Vol. 3. (Florida Power and Light Co.). May 12, 1969. 449p. (DOCKET-50251-14). Dep. CFSTI.

Final design and safety information on Turkey Point Power Reactor, Units 3 and 4 is given on the following broad topics: Waste Disposal and Radiation Protection; Conduct of Operations; Initial Tests and Operations; and Safety Analyses. (M.L.S.)

**31112** (DOCKET-50263-20) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. [Final Safety Analysis Report], Amendment 13, Vol. 7. (Northern States Power Co., Minneapolis, Minn.). Apr. 23, 1969. 200p. Dep. CFSTI.

Details of the Monticello Power Reactor, Unit 1 pressure vessel design and fabrication are given. Included are: purchase specifications, manufacturer's data report and vessel certification, tensile test report, summary stress report, fabrication and assembly report, and an independent stress analysis report. (M.L.S.)

**31113** (DOCKET-50269-7) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 7, Vol. 1. (Duke Power Co., Charlotte, N. C.). May 29, 1969. 436p. (DOCKET-50270-7; DOCKET-50287-4). Dep. CFSTI.

Final design and safety information on the Oconee Power Reactor, Units 1, 2, and 3 is given on the following broad topics: Introduction and Summary; Site and Environment; Reactor; Reactor Coolant System including in-service inspection; Structures including structural design bases; and Engineered Safeguards. (M.L.S.)

**31114** (DOCKET-50269-8) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 7, Vol. 2. (Duke Power Co., Charlotte, N. C.). May 29, 1969. 428p. (DOCKET-50270-8; DOCKET-50287-5). Dep. CFSTI.

Final design and safety information is given on Oconee Power Reactor, Units 1, 2, and 3 on the following broad topics: Instrumentation and Control; Electrical Systems; Auxiliary and Emergency Systems; Steam and Power Conversion System; Radioactive Wastes and Radiation Protection; Conduct of Operations including technical qualifications; Initial Tests and Operation; Safety Analyses; and Technical Specifications. (M.L.S.)

**31115** (DOCKET-50321-9) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. [Preliminary Safety Analysis Report], Amendment 5. (Georgia Power Co., Atlanta). Apr. 9, 1969. 148p. Dep. CFSTI.

Changes in the Board of Directors and principal officers of Georgia Power Company, owners of the Edwin I. Hatch Power Reactor, Unit 1 are listed. Coding system surveillance schedules are tabulated. Other revised pages are included. (M.L.S.)

**31116** (DOCKET-50322-8) SHOREHAM NUCLEAR POWER STATION, [UNIT 1]. Preliminary Safety Analysis Report, Amendment 5. (Long Island Lighting Co., Mineola, N. Y.). Apr. 25, 1969. 525p. Dep. CFSTI.

Effects of construction of a proposed Long Island-Connecticut bridge on the population distribution near the Shoreham Power Reactor, Unit 1 site are assessed. Potential flood levels at the site, resulting from a prolonged northeaster, are evaluated. Details of interpretation and compliance with AEC Design Criterion 35 are discussed. In-service inspection of the primary system is described; an inspection schedule is given. Accumulation of hydrogen in the primary containment vessel after a hypothetical coolant loss accident is discussed; potential effects are analyzed. Design of the control rod drive housing is evaluated. Required net positive suction head for the three Emergency Core Cooling Systems (ECCS) pumps is tabulated by system requirements. Operational modes, corresponding design conditions, and respective heat loads are tabulated for the residual heat removal system heat exchangers. The control rod position indicating system is described. Criteria used to establish locations for the radiation monitors are listed. Design of the recirculation flow monitors is described. Controls which actuate the switches and breakers for the off-site power supply for the engineered safety features are listed. Estimates of tritium releases during normal operation are given. The proposed preoperational test program is summarized. Earthquake response spectra are given for the Shoreham site; soil properties and earthquake induced shear stresses in the soil are evaluated. Coring data-logs are included. The wind tunnel test program is detailed. A fracture mechanics analysis is given to illustrate the relationship between fracture toughness and the thickness of material of the reactor coolant pressure boundary. The results of pressure suppression tests performed for the Bodega Bay Power Reactor are included. (M.L.S.)

**31117** (DOCKET-50322-9) SHOREHAM NUCLEAR POWER STATION, [UNIT 1]. Preliminary Safety Analysis Report, [Amendment 4], Vol. 1. (Long Island Lighting Co., Mineola, N. Y.). Apr. 21, 1969. 960p. Dep. CFSTI.

A completely revised Preliminary Safety Analysis Report on Shoreham Power Reactor, Unit 1 is given to supersede the original. Information is included on: Introduction and Summary; Site and Environs; Reactor Core; Reactor Coolant System; and Containment Systems. (M.L.S.)

**31118** (DOCKET-50322-10) SHOREHAM NUCLEAR POWER STATION, [UNIT 1]. Preliminary Safety Analysis Report, [Amendment 4], Vol. 2. (Long Island Lighting Co., Mineola, N. Y.). Apr. 21, 1969. 368p. Dep. CFSTI.

A completely revised Preliminary Safety Analysis Report on Shoreham Power Reactor, Unit 1 is given to supersede the original. Information is included on: Engineered Safeguards; Instrumentation and Control; Electrical Power Systems; and Radioactive Waste Systems. (M.L.S.)

**31119** (DOCKET-50322-11) SHOREHAM NUCLEAR POWER STATION, [UNIT 1]. Preliminary Safety Analysis Report, [Amendment 4], Vol. 3. (Long Island Lighting Co., Mineola, N. Y.). Apr. 21, 1969. 512p. Dep. CFSTI.

A completely revised Preliminary Safety Analysis Report on Shoreham Power Reactor, Unit 1 is given to supersede the original. Information is included on: Auxiliary Systems; Power Conversion System; Structures and Shielding; Station operations; and Safety and Accident Analyses. Appendices contain: seismic analysis, core thermal design analyses, control rod drive system description and analysis, loading criteria for the nuclear steam supply system, the quality assurance program, an outline of the proposed Technical Specifications, and a comparison of station design with the AEC General Design Criteria. (M.L.S.)

**31120** (DOCKET-50341-1) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Vol. 1, Exhibit C. (Detroit Edison Co., Mich.). Apr. 29, 1969. 365p. Dep. CFSTI.

Information on the Enrico Fermi Power Reactor, Unit 2 is given on the following broad topics: Introduction and Summary; Site; and Reactor. (M.L.S.)

**31121** (DOCKET-50341-2) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Vol. 2, Exhibit C. (Detroit Edison Co., Mich.). Apr. 29, 1969. 200p. Dep. CFSTI.

Information on the Enrico Fermi Power Reactor, Unit 2 is given on the following broad topics: Reactor Coolant System; Containment; and Core Standby Cooling Systems. (M.L.S.)

**31122** (DOCKET-50341-3) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Vol. 3, Exhibit C. (Detroit Edison Co., Mich.). Apr. 29, 1969. 301p. Dep. CFSTI.

Safety analyses of the design of the Enrico Fermi Power Reactor, Unit 2 control systems and instrumentation are detailed. (M.L.S.)

**31123** (DOCKET-50341-4) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Vol. 4, Exhibit C. (Detroit Edison Co., Mich.). Apr. 29, 1969. 330p. Dep. CFSTI.

Information on the Enrico Fermi Power Reactor, Unit 2 is given on the following broad topics: Electrical Power Systems; Radioactive Waste System; Auxiliary Systems; Power Conversion

Systems; Station Structures and Shielding; Conduct of Operations; and Plant Safety Analysis. (M.L.S.)

**31124** (DOCKET-50341-5) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Vol. 5, Exhibit C. (Detroit Edison Co., Mich.). Apr. 29, 1969. 174p. Dep. CFSTI.

Pressure integrity of piping and equipment pressure parts for the Enrico Fermi Power Reactor, Unit 2 is analyzed in detail. An outline of the proposed Technical Specifications is given. Loading criteria for systems and structures design are detailed. Station design conformance to the AEC General Design Criteria is assessed. (M.L.S.)

**31125** (DOCKET-50341-6) [ENRICO FERMI ATOMIC POWER PLANT, UNIT 2]: APPLICATION FOR LICENSES. (Detroit Edison Co., Mich.). Apr. 29, 1969. 48p. Dep. CFSTI.

Financial qualifications of the Detroit Edison Company, owners of proposed Enrico Fermi Atomic Power Plant, Unit 2, are given. The 1968 Annual Report of Detroit Edison is included. (M.L.S.)

**31126** (GAMD-9115) WATER REMOVAL RATES FROM FIBROUS THERMAL INSULATION FOR THE PUBLIC SERVICE COMPANY OF COLORADO POWER PLANT. Tung, T. V. (Gulf General Atomic, Inc., San Diego, Calif.). Apr. 30, 1969. Contract AT(04-3)-633. 24p. Dep. CFSTI.

Fibrous insulation materials have been proposed for use in thermal barriers. One of the areas of concern is the water release from the material into the core. The time required for water removal prior to reactor startup as a result of two postulated steam generator accidents has been calculated. The first accident considered is a subheader rupture with normal protective action. It is calculated that the resultant water concentration is sufficiently low so that the reactor may be started as soon as the necessary repairs are completed. The second accident considered is a subheader rupture with the wrong loop dump. Reactor shutdown is through overpressurization protection. In this case it is calculated that a moisture cleanup period of about three days is necessary before the reactor may be started up again. This is quite reasonable in terms of reactor down time cost for such a serious accident. (auth)

**31127** (PINSTECH/RT-1) RESONANCE ABSORPTION IN KANUPP LATTICE. Bhatti, Rashid A.; Mannan, M. A. (Pakistan Inst. of Nuclear Science and Technology, Islamabad. Reactor Theory Div.). 1968. 49p. Dep.

Resonance integrals were calculated for a 19-rod cluster of $UO_2$ fuel elements in a heavy water cooled and moderated lattice in the Karachi Power Reactor. The first collision probability was calculated by taking explicitly into account the heterogeneity of the cluster. Resonance integrals calculated by this method were compared to calculations by the homogeneous method and the rational approximation method. Computer codes developed for performing the calculations are outlined. (H.D.R.)

**31128** (TID-25078) GARIGLIANO NUCLEAR POWER PLANT. Operation Report for the 4th Quarter of 1968. (Ente Nazionale per l'Energia Elettrica, Latina (Italy)). Dec. 31, 1968. 22p. Dep. CFSTI.

Operations during October to December 1968 are reported. Power output averages are listed. Core maps during the quarter are presented. Coolant chemistry is analyzed. Radiation doses for personnel during October to December are listed. (D.C.C.)

**31129** (ZJE-38) THE FIRST CZECHOSLOVAK NUCLEAR POWER PLANT AND PERSPECTIVES OF NUCLEAR POWER IN CZECHOSLOVAKIA. Hulovec, Jan (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Plant Div.). Aug. 1968. 9p. (CONF-661141-1). Dep.

From 3rd National Symposium on Heat Engineering, Zagreb, Yugoslavia.

A review of nuclear power plant developments in Czechoslovakia is presented. Design parameters for the Bohunice Power Reactor Unit 1 and planned A-2 reactor are listed. Predicted development trends for nuclear power in Czechoslovakia during 1970 to 2000 are analyzed. (D.C.C.)

**31130** SEARCHING FOR FAILED FUEL ELEMENTS AT THE GUNDREMMINGEN NUCLEAR POWER PLANT. Schroeder, H. J. (Kernkraftwerk RWF-Bayernwerk GmbH, Gundremmingen, Ger.). Kerntechnik, 11: 139-43(Mar. 1969). (In German and English).

Techniques for locating failed fuel elements are discussed briefly. The wet sipping method is described in some detail. Results of application of this method to failed fuel detection in the Gundremmingen (KRB) Power Reactor, during routine shutdown, are given. (M.L.S.)

**31131** COMPARISON OF THE PHYSICAL CALCULATIONS RESULTS AND OF THE OPERATIONAL DATA OF THE WWER-2 REACTOR FIRST FUEL CHARGE IN THE RHEINSBERG NUCLEAR POWER STATION. Belyaeva, E. D.; Novikov, A. N.; Petrunin, D. M.; Savchouk, Yu. I.; Shabalov, A. I. (Inst. for Atomic Energy, Moscow). Kernenergie, 12: 56-60(Feb. 1969). (In German).

The physical and thermodynamic characteristics of the Nevo-Veronezh Power Reactor, Unit 2 are described. Critical rod bank heights are shown as a function of water coolant temperature. Fuel burnup at beginning of core lifetime, during operation, and end of life is described; critical rod bank heights are shown for each period of life. (M.L.S.)

**31132** INSTRUMENTS–COMPUTER INTERFACE PROBLEMS IN CEGB NUCLEAR POWER STATIONS. Jervis, M. W.; Bareham, R. C. (Central Electricity Generating Board, London). pp 9-13 of Conference on Industrial Measurement Techniques for On-line Computers, London, 11th–13th June, 1968. London, Institution of Electrical Engineers, 1968.

See CONF-680653.

The current practice in CEGB Advanced Gas Cooled Reactor power stations is to employ a comprehensive on-line computer system which scans the plant, processes the information and displays it to the operator or uses it for control purposes. Typically the inputs comprise about 5,000 analog and over 5,000 digital inputs per station. Standardization of the plant equipment-computer scanner specification yields the usual benefits and progress has been made towards a standard interface. Although it has not been feasible to standardize completely, and in spite of the problems involved, progress made has proved useful in the integration of large systems. (UK)

**31133** APPRAISAL STUDY OF REPORTED OPERATING EXPERIENCES OF VARIOUS FAST BREEDER REACTORS IN THE WORLD. II. ENRICO FERMI ATOMIC POWER PLANT. Nakagawa, Hiroshi; Futami, Tsuneo (Tokyo Electric Power Co., Inc.). J. At. Energy Soc. Jap., 11: 292-300(May 1969). (In Japanese).

**31134** ATOMIC POWER: WHO LOOKS AFTER PUBLIC SAFETY. Ackerman, Adolph J. Mech. Eng., 91: No. 6, 38-43(June 1969).

The emerging technology of nuclear power is reviewed from the viewpoint of basic policy and public safety. Deficiencies in these areas are examined, and an appeal is made for a higher level of integrity in atomic power policy and for higher standards of engineering and corporate responsibility. (H.D.R.)

**31135** COMMENTS ON PERFORMANCE OF BRITISH POWER REACTORS. Fair, D. R. R. J. Brit. Nucl. Energy Soc., 8: 133 (Apr. 1969).

Attention is drawn to the high load factors of the commercial Magnox reactors, difficulties encountered and overcome with on-load refuelling, and the absence of radiation and contamination problems. Advantages of the AGR system are considered. (UK)

**31136** REVIEW OF EXPERIENCE WITH GAS-COOLED REACTOR POWER STATIONS. Moore, R. V. (United Kingdom Atomic Energy Authority, Risley, Eng.). J. Brit. Nucl. Energy Soc., 8: 123-32(Apr. 1969).

The world gas-cooled reactor programme is reviewed. A description is given of overall operating experience with commercial Magnox type reactors in the UK, including a provisional analysis of outages, and also of operating experience with specific reactor components. Future developments are discussed. (UK)

**31137** NUCLEAR POWER. Jensen, W. G. London, G. T. Foulis and Company, 1969. 172p. 56s.

The following topics are discussed: the emergence of nuclear power; the European challenge; the "lean" years of nuclear energy; the present situation; and prospects for the future. (UK)

## Power Reactor Development

*Refer also to abstracts 28941, 29139, and 29140.*

**31138** (AEEW-M-845) THE WIMS MULTIGROUP SCHEME STATUS AND DIFFERENCE BETWEEN VERSIONS. Roth, M. J. (Atomic Energy Establishment, Winfrith (England)). 1969. 9p. Dep. CFSTI. UK 1s. 9d.

The present status of the WIMS programme for multigroup lattice calculations is indicated and the differences between different versions are pointed out. The version previously described by Roth, known as WIMS C, is now working on the ICL KDF9 and the IBM 7030 and 360 computers. In WIMS D known errors in WIMS C were corrected and new options introduced, most of which were made specifically to facilitate reactor design calculations. Extensions to the leakage and burn-up calculations

should help to make WIMS D more suitable as an assessment tool. WIMS D is now working on the KDF9 and the 7030 computers, while the 360 version is being brought up to WIMS D standard. (5 references) (UK)

**31139** (DUN-5508) COMPUTER PROGRAM FOR FAULT TREE ANALYSIS. Crosetti, P. A. (Douglas United Nuclear, Inc., Richland, Wash.). Apr. 1969. 29p. Dep. CFSTI.

The fault tree analysis technique is used to describe the critical reactor systems and to provide quantitative performance results. The computer program presented is used for evaluating the functional performance of nuclear reactor protective systems in terms of system reliability and availability. The Monte Carlo fault tree simulation program is written in FORTRAN 5 for the UNIVAC 1108. (D.C.C.)

**31140** (KFK-881) ON THE DEVELOPMENT OF FAST BREEDERS. Haefele, W. (Kernforschungszentrum, Karlsruhe (West Germany)). Nov. 1968. 47p. (CONF-681101-30). Dep.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

The status of fast breeder reactor research and development is reviewed, and specific aspects of fast reactor physics, fuel element performance, safety, and coolant technology are discussed. First generation fast breeder reactors and critical assemblies are tabulated, and the results of some physics and materials investigations are presented. 87 references. (H.D.R.)

**31141** (SC-R-69-1236) HUMAN RELIABILITY ASSESSMENT IN NUCLEAR REACTOR PLANTS. Swain, Alan D. (Sandia Labs., Albuquerque, N. Mex.). Apr. 1969. 29p. Dep. CFSTI.

A means of assessing the effects of human errors on reliable, safe, efficient, and economical operation of nuclear reactor plants is described. The following are presented: a definition of what is meant by human errors in a man-machine system context; some findings on human reliability; a description of two different approaches to increasing human reliability; an objective and systematic way to quantitatively assess human reliability in nuclear reactor plants based on records of human errors in plant operations and derived human performance data obtained by using task simulations, expert judgments, and existing human performance data banks; a recommendation and suggested approach whereby nuclear reactor plant agencies can pool their resources to develop a human performance data bank based on nuclear plant operations. 44 references. (auth)

**31142** PUMPED STORAGE: THE HANDMAIDEN OF NUCLEAR POWER. Knapp, Sherman R. IEEE (Inst. Elec. Electron. Eng.), Spectrum, 6: No. 4, 46-52(Apr. 1969).

The power companies of the New England states, where fossil-fuel cost is high, have determined that low-variable-cost nuclear generation is desirable for this region. The construction of pumped-storage hydro plants, favored by the topography of the area, will offset the relatively high fixed costs of nuclear plants by maximizing the capacity-use factor of the nuclear facilities and thereby minimizing the total cost per unit of energy output. This combination provides efficient base load, economical peaking capacity, and effective spinning reserve, along with many recreational and other social benefits. Economic considerations are analyzed. (auth)

**31143** FAST BREEDER CONCEPT. Goulding, B. J.; Croft, M. W. Power Eng., 73: No. 5, 34-7(May 1969).

Design parameters for a conceptual 1000 MW(e) liquid Na-cooled fast breeder reactor are described. (D.C.C.)

**31144** ONLY HIGH GAIN BREEDER REACTORS CAN STABILIZE URANIUM FUEL REQUIREMENTS. Rengel, J. C. (Westinghouse Electric Corp., Pittsburgh). Atompraxis, 15: 100-4(Mar.-Apr. 1969).

The rapid growth of water reactor capacity has accelerated the economic desirability of the high-gain breeder reactor. The breeder will be used in partnership with water reactors to supply base load, and will breed more fissionable fuel than it consumes for use in other reactors. (auth)

**31145** SODIUM-COOLED BREEDER REACTORS, A MAJOR COMPONENT OF POWER SYSTEMS IN THE FUTURE. Lundell, Bertil (Aktiebolaget Atomenergi, Nykoping, Sweden). Tek. Tidskr., 99: 347-51(1969). (In Swedish).

A review is made of Na-cooled breeder reactors. The general trends of development, systems, components and safety aspects are discussed. The properties of Na and different fuel element materials are briefly described. (Sweden)

**31146** ENEA AND EUROPEAN NUCLEAR ENERGY. Atompraxis, 15: 84; 86-8(Mar.-Apr. 1969).

Developments on ENEA's Halden, Dragon and Eurochemic joint undertakings, the ENEA Computer Programme Library at Ispra and the ENEA Neutron Data Compilation Centre at Saclay are described. Specialist committees in the fields of scientific co-operation (nuclear data, reactor physics, direct conversion) are mentioned, together with studies of nuclear fuel resources and the fuel cycle characteristics of different reactor types. The Agency's work on legal and regulatory questions, and in connection with radioactive waste disposal at sea, is also described. Finally, some possible future developments are noted. (auth)

**31147** FUTURE TECHNOLOGY OF THE GAS-COOLED REACTOR. Vaughan, R. D. (Nuclear Power Group Ltd., Knutsford, Eng.). J. Brit. Nucl. Energy Soc., 8: 134-48(Apr. 1969).

Developments in future AGR systems which would lead to reduced initial investment are discussed. Coated fuel particles and various fuel geometries designed to increase fuel rating are described. A comparison is made with the designs and economics of high temperature gas cooled reactor systems operating with either steam or gas turbines. The state of gas-cooled fast reactor technology is also reviewed. (UK)

**31148** FRENCH ENERGY POLICY WITHIN THE FRAMEWORK OF THE EUROPEAN ECONOMIC COMMUNITY. Fillon, Rene. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 75, 5-19(Jan.-Feb. 1969). (In French).

The character and mechanisms of the evolution of energy production in France are briefly discussed. Nuclear fuel resources are estimated, and the advantages and disadvantages of uranium importation are examined. The long-term development aspects of French power reactors are summarized. (H.D.R.)

**31149** MOLTEN-SALT BREEDER REACTORS. Rosenthal, M. W.; Robertson, R. C.; Bettis, E. S. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Int., 14: 420-5(May 1969).

The design and performance of 1000 MW(e) breeders are considered and the commercial prospects of the system are discussed. (auth) (UK)

**31150** STOCHASTIC MODELS OF POWER REACTOR DYNAMICS. Barrett, P. R.; Thompson, J. J. (Univ. of New South Wales, Kensington). J. Nucl. Energy, 23: 147-56(Apr. 1969).

The stochastic description of a general nuclear power reactor is formulated in terms of the multidimensional concentrations of neutrons and all nuclear species present in the reactor. The description is based on the development of a probability balance equation derived by considering all possible transitions that can occur in the reactor system in a very small time interval. Simplifications of the general formulation to tractable approximate stochastic models of power reactor dynamics are discussed. (auth) (UK)

**31151** SURVEY OF JAPAN. Nucl. Eng. Int., 14: 397-418(May 1969).

The development and utilization of nuclear energy in Japan is reviewed. Articles included report the status of work on advanced thermal reactors, fast reactors, and nuclear ships, and on fuel fabrication and reprocessing. Progress in industrial applications of radioisotopes and radiation, and in controlled thermonuclear research is also reported. A chart shows the relationships between the government bodies, research facilities, projects, and industrial companies. (UK)

## *Kinetics and Dynamics*

*Refer also to abstracts 31230,and 31234.*

**31152** (AEEW-M-834) LILLY: A COMPUTER CODE FOR CALCULATING AN INFERRED K-INFINITY FROM REACTION RATE MEASUREMENTS IN THERMAL REACTOR SYSTEMS. Hibberd, M. J.; Kendall, K. C. (Atomic Energy Establishment, Winfrith (England)). Aug. 1968. 31p. Dep. CFSTI. UK 4s. 6d.

The program LILLY uses measured reaction rates to calculate corrections to a theoretical estimate of k-infinity. A cell calculation, giving an estimate of k-infinity, is followed by a fundamental mode leakage calculation which includes predictions of reaction rates in a critical spectrum. The differences between the computed and a set of measured reaction rates are then used to correct the theoretical value of k-inf to obtain a k-inf (reaction rate). The program was written specifically for the analysis of SGHW reactor experiments and uses a METHUSELAH group structure. (auth) (UK)

**31153** (AEEW-R-622) A USER'S GUIDE TO GENEX, SDR, AND RELATED COMPUTER CODES. Brissenden, R. J.; Durston, C. (Atomic Energy Establishment, Winfrith (England)). Aug. 1968. 177p. Dep. CFSTI. UK 23s. 0d.

Development of the GENEX-SDR computer codes, started in August 1962, as a method for calculating fast reactor Doppler

coefficients in the resonance region, has since been extended to the large-scale generation of cross-sections. These are generated by the code GENEX from resonance parameters generated by the code RESP and stored on tape. The codes PODGE and SUNNY are used for evaluation of the input data to RESP, the former for the unresolved region and the latter, being a card-input version of GENEX, for the resolved region. The aim was to by-pass the various approximations that existed and to treat the resonance region in fine detail. The code was originally envisaged as covering the range from 65 keV to thermal energies, but machine time considerations caused this to be curtailed to the range from 20 keV (approximately 120,000 groups). This was later extended to 25 keV to enable the analysis of antimony-beryllium source experiments to be carried out. Additions, alterations, and some clarifications of the aims and methods used are described. 31 references. (UK)

**31154** (BNWL-954) 1DX: A ONE-DIMENSIONAL DIFFUSION CODE FOR GENERATING EFFECTIVE NUCLEAR CROSS SECTIONS. Hardie, R. W.; Little, W. W. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1969. Contract AT(45-1)-1830. 119p. Dep. CFSTI.

1DX is a multipurpose, one-dimensional (plane, cylinder, sphere) diffusion theory code for use in fast reactor analysis. The code is designed to: compute $k_{eff}$ and perform criticality searches on time absorption, reactor composition, reactor dimensions, and buckling by means of either a flux or an adjoint model; compute and punch collapsed microscopic and macroscopic cross sections averaged over the spectrum in any specified zone; and compute and punch resonance shielded cross sections using data in the "Russian" format. All programming is in FORTRAN-IV. Since variable dimensioning is employed, no simple restrictions on problem complexity can be stated. In a 65K memory, 100-group problems are feasible for a moderate number of mesh intervals (~30). A representative 26-group $k_{eff}$ calculation with 30 spatial intervals using data in the "Russian" format requires about 40 seconds on a UNIVAC 1108. If the cross section data is in the "DTF" format, the same problem would require about 5 seconds. 7 references. (auth)

**31155** (BNWL-962) REVISED FAST REACTOR LIBRARY FOR USE WITH RIBD. O'Dell, L. D.; Bunch, W. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1969. Contract AT(45-1)-1830. 28p. Dep. CFSTI.

A revised nuclear data library has been generated for use with RIBD to calculate fission product inventories and decay heat rates associated with fuels irradiated in fast reactor environments. Nuclear data include fission yield from both $^{239}Pu$ and $^{238}U$, half life, capture cross section, and decay energies for each of 450 isotopes and isomeric states that can be produced as a result of fission. Recent literature was reviewed to obtain available experimental data. Theoretical values were employed as necessary to complete the library. 8 references. (auth)

**31156** (BNWL-992) A NUMERICAL COMPARISON OF DIFFUSION AND TRANSPORT ($S_n$) CODES FOR SELECTED FAST REACTOR CONFIGURATIONS. O'Dell, L. D.; Hardie, R. W.; Little, W. W. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1969. Contract AT(45-1)-1830. 31p. Dep. CFSTI.

Numerical comparisons between the one-dimensional diffusion code, 1DX, and the one-dimensional transport code, DTF-IV, are described. The objective of the comparison is to determine under what circumstances diffusion codes are sufficiently accurate to be used in place of transport codes. For large breeder reactors, it is found that diffusion theory is adequate to compute virtually all preliminary design parameters, including control rod worths and neutron fluxes far from the core. (auth)

**31157** (IAE-1641) THEORY OF THE CRITICALITY OF A REACTOR DURING OSCILLATIONS OF THE FUEL DENSITY. Novikov, V. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1968. 17p. (In Russian). Dep.

Uniform distribution of the fuel does not represent the optimum loading of a reactor; the critical mass reaches a minimum when the fuel is more strongly concentrated in the central portion of the core. A just-critical reactor with uniformly distributed fuel becomes supercritical if the fuel is shifted toward the center; a gaseous fuel may thus be affected by acoustical oscillations. Thus, the dynamic behavior of the reactor may be controlled by exciting acoustical oscillations in the fuel channels containing a gaseous fuel; the oscillations must be in the same phase in all channels. This requires a simultaneous solution of the gas hydrodynamics and neutron balance equations. The inverse effect of the neutron flux on the gas hydrodynamics is neglected; this condition is satisfied for fluxes between $10^{13}$ to $10^{14}$. Stationary waves are formed in all of the channels of the reactor. After reviewing the conditions for an infinite reactor, the finite case was examined. It was found that in a sufficiently large reactor, when the density oscillations reach about 5% of the mean density, the supplementary reactivity is of the same order as the proportion of delayed neutrons. This potential method for controlling the criticality of a reactor by generating density oscillations in the fuel is inherently safe because the oscillations are stopped when the reactivity is reduced. The amplitude of neutron-flux pulsations exceeds the amplitude of density oscillations by a factor of $(k_\infty - 1)^{-\frac{1}{2}}$; this may be used to generate a high-amplitude pulsed flux. (TTT)

**31158** (ORNL-TM-2582) EFFECT OF STEAM DENSITY ON REACTIVITY IN THREE STEAM COOLED FAST BREEDER REACTORS. Welfare, F. G. (Oak Ridge National Lab., Tenn.). May 23, 1969. 17p. Dep. CFSTI.

The effect of changes in steam density on reactivity has been calculated for three steam cooled breeder reactors of 3600, 2500, and 1200 psi operating pressure. When flooded at end of life the systems show reactivity increases of 4%, 1%, and 16% for the high, intermediate, and low-pressure systems. When voided at beginning of life the systems show increases in reactivity of .5%, 2%, and .9% for the high, intermediate, and low-pressure systems. When voided at end of life the intermediate, and low-pressure systems show increases in reactivity of 1.9% and 0.7%, respectively, and the high-pressure system shows a decrease in reactivity of 3.8%. 9 references. (auth)

## Control Systems

**31159** (BNWL-1031) STATUS OF REACTIVITY CONTROL TECHNOLOGY FOR HEAVY WATER MODERATED REACTORS. Worden, J. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 22p. Dep. CFSTI.

A brief review has been made of the status of technology in control system design for heavy water reactors. A review of control mechanisms for heavy water reactors is presented. A review of control systems used in current heavy water reactors is also included. 14 references. (auth)

**31160** IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Knights, Herbert Chilvers (to United Kingdom Atomic Energy Authority). British Patent 1,152,003. May 14, 1969. Filed Aug. 17, 1965.

The control system described consists of a means to lock the displaceable control pin in a position relative to the fuel assembly where it has the maximum reducing effect on neutron flux in its vicinity. The system locks as a direct result of disconnecting the control mechanism from its fuel assembly. An embodiment designed for a PWR is described. (UK)

## Cooling Systems

*Refer also to abstract 29249.*

**31161** (EURAEC-2058) DEVELOPMENT PROGRAM ON THE APPLICATION OF STEAM-WATER SPRAY TO REACTOR COOLING. IN-PILE EXPERIMENTS ON STEAM-WATER MIXTURES: EQUIPMENT AND METHODS OF MEASUREMENT. Topical Report No. 6. Cerrai, E.; Gadda, F.; Ronchetti, C.; Scaroni, A. (Centro Informazioni Studi Esperienze, Milan (Italy)). Mar. 1968. Contract 056-62-1-RDI. 52p. (EUR-3996; CISE-R-139). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

A description is given of equipment and methods used during the work on water chemistry and corrosion under irradiation. The following items are dealt with: methods used for radioactive crud analysis; design and construction of a shielded cell for determining corrosion rate on radioactive corrosion samples; analysis of hydrogen in Zircaloy-2 by vacuum hot extraction technique; and analysis of radiolytic gases by pressure measurements and by on-line chromatography. (auth)

**31162** CIRCULATING PUMP FOR AN INTEGRAL NUCLEAR REACTOR. Junkermann, Wolfgang; Sachse, Bruno (to Babcock and Wilcox, Ltd.). U. S. Patent 3,437,559. Apr. 8, 1969. Priority date May 17, 1966, Germany.

A circulating pump connected to a nuclear reactor pressure vessel and having an impeller wheel which is detachable from the drive shaft is described. A clamping device adjustable from a position external of the pressure vessel is used to operatively engage the impeller wheel with the drive shaft. The clamping device employs frictional force to achieve the bond between the impeller and the shaft. An alternate arrangement shows a spline-tooth gear construction to engage the impeller and the shaft. The

opening in the reactor pressure vessel is sized to allow passage of the shaft and its associated bearings. (Offic. Gaz.)

**31163** NUCLEAR POWER PLANT. Chermanne, Jean-Marie Georges Eugene Ghislain; Fossoul, Emile Auguste Joseph; Van Dievoet, Jean-Paul Laurent (to Societe Belge Pour L'Industrie Nucleaire). British Patent 1,151,683. May 14, 1969. Filed Mar. 6, 1967.

Reference is made to Na-cooled fast reactors. In the heat exchangers of such reactors a water-radioactive Na reaction hazard is always present as a consequence of a possible leak or tube failure. Furthermore, since the water-steam loop pressure is much higher than that of the primary Na loop, means must be adopted to prevent the possibility of water ingress to the reactor core. An intermediate non-active Na heat transfer loop is therefore generally provided between the primary radioactive Na and the water-steam circuits. The object of the arrangement described is to simplify this three-loop sysem, and eliminate the possibility of a water–Na reaction. The intermediate and turbine loops are replaced by a $CO_2$ closed circuit. A number of variants of the $CO_2$ circuit are described. (UK)

**31164** STEAM GENERATORS FOR PWR NUCLEAR PLANTS. Jankowski, Z.; Kurpisz, L. (Technical Univ., Warsaw). Pol. Tech. J., 11: 1303-10(1967). (In Polish).

Classification of steam generators for PWR nuclear plants is presented. Basic problems of design, production and exploitation of steam generators are analyzed. Optimum parameters are described. (NSA of Poland)

## Fuels

*Refer also to abstracts 29982, and 30192.*

**31165** (KFK-805) TEMPERATURE AND STRESS DISTRIBUTIONS IN FUEL ROD CLADDINGS WITH SPIRAL SPACERS FOR STEAM-COOLED FAST BREEDER REACTORS. Hoffmann, H.; Rust, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). June 1968. 77p. (In German). (EUR-3965). Dep.

The temperature fields and stresses in clad rods with spiral spacers are influenced by the geometry of the spacers, the local heat transfer conditions, and the operating conditions. The number of ribs is important for determination of the maximum temperature. Six ribs per tube give insignificantly smaller comparative stresses than 3 ribs. The thermal conductivity of the material has little influence on the temperature profile. Smooth ribbed tubes with slanting sides gave essentially identical temperature distributions in the walls as those with even sides or rough surfaces and at the same time smaller stresses to the rib top. Calculations for transient operating conditions gave a very strong temperature increase in the first 5 seconds after beginning and the fuel rod cladding burden reached a maximum during this short time span. Results are given in tables and graphs. 11 references. (M.C.G.)

**31166** (NUMEC-3524-58) DEVELOPMENT AND TESTING OF $PuO_2$–$UO_2$ FAST REACTOR FUELS. 14th Quarterly Report, July–September 1968. (Nuclear Materials and Equipment Corp., Leechburg, Pa. Plutonium Lab.). Mar. 1969. Contract AT-(30-1)-3524. 18p. Dep. CFSTI.

PLUTONIUM OXIDES $PuO_2$ — $PuO_2$ – $UO_2$, fuel development program for fast reactors during July to September 1968
— $PuO_2$ – $UO_2$, radiation effects on NUMEC Series A pellet shaped
— $PuO_2$ – $UO_2$, fabrication of pellet shaped, procedures for
REACTOR FUEL ELEMENTS— radiation effects on NUMEC Series A plutonium oxide ($PuO_2$) – uranium oxide ($UO_2$) pellet type
— fabrication of fast reactor plutonium oxide ($PuO_2$) – uranium oxide ($UO_2$) pellet type, procedures for
REACTORS, FAST — fuel development program for, operations during July to September 1968 for plutonium oxide ($PuO_2$) – uranium oxide ($UO_2$)
— fuel elements for, radiation effects on NUMEC Series A plutonium oxide ($PuO_2$) – uranium oxide ($UO_2$) pellet type
— fuel elements for, fabrication procedures for plutonium oxide ($PuO_2$) – uranium oxide ($UO_2$) pellet type
URANIUM OXIDES $UO_2$ — $PuO_2$ – $UO_2$, fuel development program for fast reactors during July to September 1968
— $PuO_2$ – $UO_2$, radiation effects on NUMEC Series A pellet shaped
— $PuO_2$ – $UO_2$, fabrication of pellet shaped, procedures for (D.C.C.)

**31167** (NUMEC-3524-62) DEVELOPMENT AND TESTING OF $PuO_2$–$UO_2$ FAST REACTOR FUELS. Quarterly Report No. 15, October–December 1968. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Apr. 1969. Contract AT(30-1)-3524. 47p. Dep. CFSTI.

PLUTONIUM OXIDES $PuO_2$ — $PuO_2$ – $UO_2$, fuel development program for fast reactors during October to December 1968
— $PuO_2$ – $UO_2$, radiation effects on NUMEC Series B and Series C pellet shaped
— $PuO_2$ – $UO_2$, fabrication of pellet shaped, problems with dimensional control in
REACTOR FUEL ELEMENTS— radiation effects on NUMEC Series B and Series C plutonium oxide ($PuO_2$) – uranium oxide ($UO_2$) pellet type
— fabrication of fast reactor plutonium oxide ($PuO_2$) – uranium oxide ($UO_2$) pellet type, problems with dimensional control in
REACTORS, FAST — fuel development program for, operations during October to December 1968 for plutonium oxide ($PuO_2$) – uranium oxide ($UO_2$)
— fuel elements for, radiation effects on NUMEC Series B and Series C plutonium oxide ($PuO_2$) – uranium oxide ($UO_2$) pellet type
— fuel elements for, dimensional control problems in fabrication of plutonium oxide ($PuO_2$) – uranium oxide ($UO_2$) pellet type
URANIUM OXIDES $UO_2$ — $PuO_2$ – $UO_2$, fuel development program for fast reactors during October to December 1968
— $PuO_2$ – $UO_2$, radiation effects on NUMEC Series B and Series C pellet shaped
— $PuO_2$ – $UO_2$, fabrication of pellet shaped, problems with dimensional control in (D.C.C.)

**31168** (RT/ING-(69)2) ANALYTICAL INVESTIGATION OF CROSSFLOW MIXING BETWEEN OPENED REACTOR CHANNELS. Grillo, P.; Szabados, L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1969. 20p. Dep.

Experimental data for crossflow mixing in a test section of two adjacent channels of a 19 rod bundle are analyzed. The bundles are typical of thermal cores for boiling and pressurized-water reactors. 3 references. (D.C.C.)

**31169** INVESTIGATIONS OF THE INFLUENCE OF VIBRATION BEHAVIOR ON THE DESIGN OF STEAM COOLED HIGH POWER FUEL ELEMENTS. Eisner, J. H. Atompraxis, 15: 93-5(Mar.-Apr. 1969). (In German).

The vibration behavior is, especially at high coolant flow velocities, one of the design criteria of rod type fuel elements with axial coolant flow. The possible modes of vibration are discussed. Here the vibration between the spacer supports is of main significance This kind of vibration is analyzed. For steam cooled fuel elements the rod diameter, the rod to rod distance, the slope of spacers, the coolant flow velocity and the vibration amplitude are optimized. (auth)

## Auxiliary and Emergency Systems

**31170** (AI-67-Memo-92) DETECTION OF NUCLEATE BOILING: REVIEW AND BIBLIOGRAPHY. Felten, L. D. (Atomics International, Canoga Park, Calif.). June 10, 1967. 9p. Dep. CFSTI.

A device to detect the onset of nucleate boiling during operation of a non-boiling type reactor, such as a sodium fast breeder reactor, could result in a lower hot channel factor and consequent operation at higher powers. A review of previous boiling noise detection work indicates that the sensitivity of the measurement for low frequency boiling noise and for system acoustic resonances which can be excited by boiling noise needs further investigation. The sodium loops at Santa Susana can be used for part of this work. 25 references. (auth)

**31171** (CONF-690113-7) FAST STARTING DIESEL GENERATORS FOR NUCLEAR PLANT PROTECTION. Tibbetts, R. L.; Ustruck, E. A.; St. John, R. F.; Thiele, O. E. (Colt Industries, Beloit, Wis. Fairbanks Morse Power Systems Div.). [1969]. 19p. IEEE.

From IEEE Winter Power Meeting, New York.

Quick and reliable response of standby power units is an essential requirement for operation of nuclear power plants during emergency shutdown conditions. A series of tests conducted to demonstrate reliability, quick response and load acceptance of one type of diesel generator set proposed for nuclear power plant standby service is analyzed. (auth)

**31172** (ORNL-TM-2412) DESIGN CONSIDERATIONS OF REACTOR CONTAINMENT SPRAY SYSTEMS. PART I. Row, T. H.; Parsly, L. F.; Zittel, H. E. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 30p. Dep. CFSTI.

Pressurized water reactors currently being designed include a containment building spray system for pressure reduction fol-

lowing a design basis accident. An additional function proposed for these spray systems is the removal of fission products, particularly iodine, released to the containment building during such an accident. A number of design considerations associated with this fission product removal in light of the information developed in the Spray and Absorption Technology Program are analyzed. Questions relating to the removal process and the radiation and thermal stability of the solutions are examined. (auth)

**31173** STANDBY DIESELS IMPROVE REACTOR SAFETY WITH ELECTRIC BACKUP FOR KEY AUXILIARIES. Bender, Rene J. Power, 113: No. 5, 65-7(May 1969).

Performance requirements for standby diesel power systems in boiling reactors, pressurized-water reactors, and gas-cooled reactors are analyzed. Operating parameters for typical systems are described. (D.C.C.)

**31174** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Cave, Leslie; Pike, Philip James; Common, Donald Keith (to Atomic Power Constructions Ltd.). British Patent 1,151,840. May 14, 1969. Filed Aug. 30, 1968.

Reference is made to facilities on nuclear reactor sites for the temporary storage of discharged gaseous coolants and fluid moderators. Such storage facilities usually take the form of costly specially constructed pressurized and/or thermally insulated vessels. In the system described, a number of storage vessels is provided comprising lengths of standard large diameter high pressure steel piping welded together with capped ends. These storage vessels are joined to a main header or supply pipe from the reactor via suitable flow control valves. The storage system is preferably buried underground. Application to a high temperature He-cooled reactor is described. (UK)

## Operation and Economics

**31175** (DUN-5381) USE OF A DEACTIVATED HANFORD REACTOR CONTROL CENTER FOR AN OPERATOR TRAINING SIMULATOR. Carrothers, M. R.; Wright, C. A. H. (Douglas United Nuclear, Inc., Richland, Wash.). Jan. 30, 1969. 39p. Dep. CFSTI.

An initial feasibility study was conducted which utilized two TR-10 Pace analog computers and the instrumentation in the deactivated D Reactor control room. From the results of the study, it was decided that an inexpensive reactor simulator would be built which would portray the spacial properties of a large production reactor. (auth)

**31176** EFFICIENCY CRITERIA FOR FAST NEUTRON NUCLEAR POWER STATIONS. Kazachkovskii, O. D.; Kirillov, E. V. (Forschungsinstitut fuer Kernreaktoren, Melekess, USSR). Kernenergie, 12: 47-51(Feb. 1969). (In German).

Efficiency criteria of fast nuclear power stations are considered; breeding ratio, thermal efficiency, doubling time, and electric energy cost are discussed. The role of each criterion is demonstrated for the fast reactor economics. The conclusion is made that only the total electric energy production costs can be the final and complete efficiency criterion. (auth)

**31177** THE OECD HALDEN REACTOR PROJECT. Aas, S. (OECD, Halden, Norway). Atompraxis, 15: 89-92(Mar.-Apr. 1969).

The principal objective of the OECD Halden Reactor Project during its first five years, from 1958 to 1963, was to obtain practical experience in the design, construction and operation of boiling heavy water reactors. The success of this work led to the subsequent adoption of a broader programme which has included research in reactor physics, dynamics and water chemistry, development of in-core instrumentation, irradiation of test fuel elements, and research in computer control. The 25 MW(t) Halden installation is described. The programmes carried out over the past ten years are reviewed. (auth)

**31178** THE OECD DRAGON REACTOR PROJECT. Saunders, R. A. (OECD High Temperature Reactor, Winfrith, Eng.). Atompraxis, 15: 96-100(Mar.-Apr. 1969).

Dragon is a fully operational, high-temperature, gas-cooled reactor (HTGCR), owned and operated by the OECD High Temperature Reactor Project (Dragon Project) at the Winfrith Establishment of the United Kingdom Atomic Energy Authority. The Dragon Project came into being on April 1, 1959, following an international Agreement which provided for the joint design, construction and operation of a 20 MW(t) high-temperature reactor experiment, and for a supporting programme of research and development on the novel aspects of HTGCR technology. This Agreement envisaged a five-year programme within a limit of expenditure of £13.6 million. While the Winfrith reactor was still under construction, a re-examination of the programme showed that more time would be needed for its full exploitation. A new agreement was therefore signed in 1962, which extended the life of the Project of March 31, 1967 with a revised budget of £25 million for the full eight-year period. During 1966 a further extension into 1970 was proposed and agreement has since been reached on a formal extension to March 31, 1970, the total budget (for the 11-year life of the Project) being increased to £31 million. The possibility of a further extension is currently under discussion. (auth)

## Safety and Siting

**31179** (ANL-7533) FUEL-FAILURE DETECTION IN LMFBR POWER PLANTS. Porges, K. G. A. (Argonne National Lab., Ill.). Feb. 1969. Contract W-31-109-eng-38. 45p. Dep. CFSTI.

The application of delayed-neutron monitoring for fastest possible shutdown in system failures is analyzed. The various effects on the signal obtained from such a channel of the type of fuel, conjectural failure mechanism, fission-product transport to the detector site, and finally, electronic processing are discussed and evaluated in the light of transient-detection statistics. Such statistical considerations strongly emphasize the need for adequate electronic processing and provide guidance in the choice of detector site and other hardware decisions. With well-designed electronics and a favorable site, a delayed neutron-monitoring system can give a failure indication within about 5 sec from the actual moment of failure, whereas a flowmeter gives an indication within 1 sec from the moment the channel becomes blocked by debris. The delayed-neutron signal should allow certain inferences regarding the type and extent of failure from the signal shape; the flowmeter, on the other hand, locates the event. The two systems thus complement each other. 21 references. (auth)

**31180** (BMI-X-10257) FISSION-PRODUCT DEPOSITION AND ITS ENHANCEMENT UNDER REACTOR ACCIDENT CONDITIONS. Quarterly Progress Report, January-March 1969. Genco, Joseph M.; Rosenberg, Harvey S.; Berry, David A.; Cremeans, George E.; Morrison, David L. (Battelle Memorial Inst., Columbus, Ohio). Apr. 1969. Contract W-7405-eng-92. 10p. (EURAEC-2103). Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

Results of effects of coolant loss accidents on containment system coatings are tabulated. Coating capacities for methyl iodide and elemental iodine, after four hours of deposition, are listed. Calculated minimum deposition velocities are given. Results of desorption of methyl iodide and elemental iodine after 24 hours in flowing He are tabulated for the coatings. 12 references. (M.L.S.)

**31181** (BNWL-1001) PREPARATION, GENERATION, AND ANALYSIS OF GASES AND AEROSOLS FOR THE CONTAINMENT SYSTEMS EXPERIMENT. Coleman, L, F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1969. Contract AT(45-1)-1830. 95p. Dep. CFSTI.

Methods for the preparation, isotopic labeling, and release of aerosols to containment systems are presented. A description of sampling methods and hardware is also presented along with a discussion of gamma energy analytical techniques employed. The systems and techniques discussed were developed in support of a Reactor Safety Program (Containment Systems Experiment) which will furnish engineering scale data on the behavior of aerosols in reactor containment systems. 22 references. (auth)

**31182** (CEA-CONF-1259) INVESTIGATION OF FUEL BEHAVIOR IN A FAST REACTOR. "SCARABEE" LOOP PROGRAM. Millot, J. P. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Feb. 20, 1969. 25p. (In French). (CONF-690208-1). Dep.

From Meeting on the Sodium-Fuel Interaction and Related Problems in the Sodium-Cooled Fast Breeder Reactor, Karlsruhe, Germany.

A program of experiments has been undertaken on the CABRI reactor, in order to study the behavior of fuel meltdown. The main stages of this program are: (a) an analysis of the possible causes of meltdown on non-irradiated and irradiated fuel; (b) an analysis of the consequences of meltdown (pressure waves, fuel behavior after meltdown, fission product release, etc.); and (c) an analysis of meltdown propagation from one pin to the next one within the same assembly and from one assembly to the next ones. (auth)

**31183** (CONF-650681-1) NUCLEAR EXCURSION TECHNOLOGY. Brammer, H. A.; McWhorter, R. J.; Wood, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Sept. 1, 1965. 56p.

From Seminar on Reactor Safeguards, Bethesda, Md.

The phenomena involved, analytical methods used, and general conclusions reached for potential reactivity excursions in boiling reactors are presented. Topics discussed include: phenomenological description and classification of nuclear excursions; reactivity insertion rates; consequences of reactivity insertion; and current state of understanding and design position. 8 references. (auth)

**31184** (IDO-17252) CONTEMPTS-PS: A DIGITAL COMPUTER CODE FOR PREDICTING THE PRESSURE-TEMPERATURE HISTORY WITHIN A PRESSURE-SUPPRESSION CONTAINMENT VESSEL IN RESPONSE TO A LOSS-OF-COOLANT ACCIDENT. Carmichael, C. F.; Marko, S. A. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1969. Contract AT(10-1)-205. 74p. Dep. CFSTI.

A complete description of the CONTEMPT-PS computer program, for prediction of the pressure-temperature history in a pressure suppression containment, is given. The pressure-containment system model is described; equations and method of solution are detailed. Complete input/output format is given; the program, itself, is listed. The program is written in FORTRAN IV with symbolic routines that convert BCD to binary, and it is written for the IBM 7040-44. A sample program is included. (M.L.S.)

**31185** (WCAP-7306) REACTOR PROTECTION SYSTEM DIVERSITY IN WESTINGHOUSE PRESSURIZED WATER REACTORS. Burnett, T. W. T. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems Div.). Apr. 1969. 174p.

Westinghouse design philosophy for Reactor Protection and Control Systems is to make maximum use, for both protection and control functions, of a wide range of measurements. The Protection and Control Systems are separate and identifiable. The design approach permits not only redundancy of control providing its own desirable increment to overall plant safety, but also provides a Protection System which continuously monitors numerous system variables by different means; i.e., protection system diversity. The extent of Protection System diversity has been evaluated for a wide variety of postulated accidents. In most cases, two or more diverse protective functions would terminate an accident before intolerable consequences could occur. (auth)

**31186** DESIGN FOR SAFETY HAS BEEN A PARAMOUNT CONCERN OF THE NUCLEAR COMMUNITY. Strauss, Sheldon D. Power, 113: No. 5, 70-1(May 1969).

A comparison of personnel injuries and fatalities due to accidents in the nuclear industry is made with other industries for a period from 1943 to 1968. Safety procedures and testing programs for the nuclear industry are reviewed. (D.C.C.)

**31187** SAFETY ASPECTS OF ATOMIC POWER PLANTS. Emmersen, Poul (Danish Atomic Energy Commission, Risoe). Ing. Bygningsv., Ugeovers., No. 3, 29-34(1969). (In Danish).

The safety principles concerning design, construction and operation of atomic power plants are reviewed with special reference to water-cooled reactors. Some aspects of the USAEC safety philosophy are discussed, and the probability approach to reactor safety and siting is described as the supposed future goal in reactor safety assessment methodology. (auth) (Denmark)

**31188** DRAFT ASME CODE FOR INSERVICE INSPECTION OF NUCLEAR REACTOR COOLANT SYSTEMS. New York, The American Society of Mechanical Engineers, 1968. 51p. $3.00

An Inservice Inspection Code is described which provides the examination and inspection requirements for pressure retaining components of light water cooled and moderated nuclear power reactors. The Code includes: inservice inspection; evaluation of examination results; repairs and replacements; system hydrostatic tests; and records. (D.C.C.)

### *Power Conversion Systems*

**31189** FATIGUE OF HEAT-EXCHANGER TUBESHEET ELEMENTS FOR NUCLEAR-PLANT DESIGN. Havard, D. G.; Clark, G. H. (Hydro-Electric Power Commission of Ontario, Toronto). Ont. Hydro Res. Quart., 20: No. 3, 1-8(Third Quarter 1968).

Six series of fatigue tests relating to the design of heat-exchanger tubesheets for nuclear power plants are described. The hydraulic loading system used, the design of specimens and the instrumentation for maintaining fully reversed, constant-amplitude loading are outlined. The results of fatigue tests on four designs of specimen related to the configuration of automatically welded tube-to-tubesheet joints show that residual stresses due to rolling have negligible effect on the fatigue strength, and that both the cladding layer of nickel and monel and the weldment of the completed joint add to the fatigue resistance of the tubesheet. The presence of lack-of-fusion defects in the cladding and the use of manually welded repairs of such defects were investigated by comparing the fatigue behavior of three designs of specimen. The effects of these welding variations were found to be not significant. (auth) (Canada)

## Research and Test Reactors

*Refer also to abstracts 28772, 28949, 29112, 29251, 29270, 29283, 29472, 31161, 31182, 31226, and 31236.*

**31190** (AD-683655) NRL REACTOR OPERATIONS REPORT, JANUARY 1, 1968-JUNE 30, 1968. Bebbs, Elbert H.; Strain, Charles V.; Vogt, Richard H. (Naval Research Lab., Washington, D. C.). Dec. 1968. 31p. (NRL-MR-1955). CFSTI.

Most aspects of reactor operations are described. The level of utilization of the reactor by in-house and outside users is discussed. Programs for which the reactor was used during the reporting period are also briefly described. (auth) (USGRDR)

**31191** (AD-684695) KAZAKHSTAN REACTOR BECOMES OPERATIONAL. Moore, R. Translated from Vestn. Akad. Nauk Kaz. SSR, 23: No. 11, 92-3(1967). 6p. (FTD-HT-23-765-68). CFSTI.

The reactor is a powerful source of neutron and $\gamma$ radiation and is designed for a wide range of scientific research experiments. Water is used both as the moderator and the reflector as well as for the coolant. It is fueled with enriched U, and is provided with approximately 30 vertical experimental channels. Ten horizontal channels can be used to bring neutron beams from the reactor core into an experimental room. The reactor is also provided with hot chambers used for the preparation and radiochemical processing of highly radioactive samples, and there are chemical chambers for the preparation and chemical processing of samples with low radioactivity. Both the hot and chemical chambers are provided with lead glass, manipulators, and other remote control devices. The reactor can be equipped with four pneumatic tubes for working with short-lived isotopes. (STAR)

**31192** (APDA-187) ALTERNATE REACTOR CONCEPT DESIGN STUDY FOR THE FAST FLUX TEST FACILITY. FIXED SHIELD PLUG, VERTICAL CORE REACTOR CONCEPT. Duffy, J. G.; Hess, J. W.; Matte, J.; Mueller, R. E.; White, J. R. (Atomic Power Development Associates, Inc., Detroit, Mich.). Apr. 30, 1966. Contract AT(11-1)-865. 50p. Dep. CFSTI.

Alternate design criteria for the FFTF includes: irradiation testing capability; physics design; reactor design; reactor control mechanisms; loops; and mechanical handling systems. (D.C.C.)

**31193** (BNWL-567) FAST FLUX TEST FACILITY PERIODIC TECHNICAL REPORT, JULY-DECEMBER 1967. Astley, E. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1969. Contract AT(45-1)-1830. 172p. Dep. CFSTI.

COAXIAL CABLES—reactor environmental effects on, analysis of
FAST TEST REACTOR—core for, design parameters for split conical
—fuel elements for, design parameters and drawings for
—refueling systems for, analysis of conceptual designs for
—instrumentation for, reactor environmental effects on signal cables for
—coolant for, methods of testing and cleaning requirements for liquid sodium
—coolant for, fission product transport and deposition analyses for liquid sodium
—fuel elements for, program for determining heat transfer characteristics of
—fuel elements for, hydraulic analyses of
—heat transfer analyses for, development of digital computer model for transient
—fuel elements for, high neutron fluence-induced swelling of austenitic stainless steel
—monitoring requirements for, outline of in-core
—fuels for, comparison of fabrication techniques for
—control rods for, comparison of calculated and measured differential worths of
—shield for, analyses of designs for
—fuel for, fission product inventory and radioactivity problems with plutonium
—accidents in, outline of methods for parametric analyses of
NEUTRONS, FAST—radiation effects on fast reactor mixed oxide fuels, review of results of
REACTOR CONTROL ELEMENTS—reactivity worth of FTR, comparison of measured and calculated differential

REACTOR FUEL ELEMENTS—design of FTR, parameters and drawings for
—heat transfer characteristics of FTR, program for
—hydraulic analysis of FTR 37-pin assemblies
—cladding for FTR driver, stress analyses for
—cladding for FTR, high neutron fluence-induced swelling of austenitic stainless steel
REACTOR FUELS—fabrication of FTR, comparison of techniques for
—radiation effects on mixed oxide fast, review of results of fast neutron
—fission product inventory for FTR plutonium
—radioactivity problems with FTR plutonium
REACTOR LOADING MACHINES—designs for FTR, analysis of conceptual
REACTOR SAFETY—accident analysis for FTR, outlines of parametric
SODIUM—cleansing methods for FTR coolant liquid, description of
—fission product transport and deposition in FTR coolant liquid, analyses of (M.L.S.)

**31194** (BNWL-760(Suppl.1)) PRELIMINARY ANALYSIS OF POSTULATED MAXIMUM ACCIDENTS FOR THE FFTF. SUPPLEMENT I. ADDITIONAL CALCULATIONS FOR SODIUM-IN CONDITIONS. Harris, R. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1968. Contract AT(45-1)-1830. 46p. Dep. CFSTI.

The core disassembly calculations reported in BNWL-760 for the particular case of "sodium-in" conditions are reevaluated. The validity of the "sodium-in" equation of state used in the referenced document is reexamined, and a newly developed expression, based on experimental data in the temperature domain of interest, is presented. The effect of Na vapor pressure as a disassembly force and the effects of Na compressibility are parametrically examined. The analysis indicates that the disassembly calculations reported in BNWL-760 for "sodium-in" conditions are probably quite pessimistic. However, a reevaluation of the effects of sodium prior to and following the disassembly phase may be necessary before one can confidently recommend energy release values which are substantially lower than those previously reported. (auth)

**31195** (BNWL-967) ANALYSIS OF FTR PHASE A CONTROL ROD EXPERIMENTS IN ZPR-III, ASSEMBLY 48 AND 48-A. Bennett, R. A.; De Myer, S. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1969. Contract AT(45-1)-1830. 54p. Dep. CFSTI.

Critical experiments in support of the design of the Fast Flux Test Reactor are to be carried out in three parts. Control rod reactivity worths and rod interactions are analyzed. The results of an analysis of the data obtained on ZPR-III Assemblies 48 and 48A are presented. 10 references. (auth)

**31196** (CEA-R-3505) STUDY OF LIQUID HYDROGEN AND LIQUID DEUTERIUM COLD NEUTRON SOURCES. Harig, Hans-Dieter (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1969. 86p. (In French). Dep.

Thesis. Submitted to Grenoble Univ., France.

In view of the installation of the cold neutron source for a high flux reactor (maximal thermal flux of $10^{15}$ n/cm$^2$s) an experimental study of several cold sources of liquid $H_2$ and liquid $D_2$ was made in a low power reactor (100 kW, $10^{12}$n/cm$^2$s). Cold neutron sources of liquid $H_2$ shaped as annular layers of different thickness were investigated. Normal liquid $H_2$ was used as well as $H_2$ with a high para-percentage. Cold neutron sources of liquid $D_2$ in cylinders of 18 and 38 cm diameter were also investigated. In this case the sources could be placed into different positions of the reactor core within the heavy water reflector. The experimental device and the design of the cryogenic systems are described. The measured results are presented, interpreted, and compared with those of a theoretical study on the same cold moderators. (auth)

**31197** (GA-7263) OPERATING CHARACTERISTICS OF ACCELERATOR-BOOSTER PULSED RESEARCH REACTORS. Stevens, C. A.; Beyster, J. R.; Russell, J. L. Jr. (Gulf General Atomic, Inc., San Diego, Calif.). July 1, 1966. Contract AT(04-3)-167. 36p. Dep. CFSTI.

A feasibility study of an accelerator-booster fast repetitively pulsed research reactor is described. Desirable operating characteristics for the booster were determined, together with its dependence upon the associated Linac. Fast neutron burst shapes, power levels, and problems of thermalizing the fast neutrons to obtain short intense bursts of thermal neutrons are discussed. Alternative reactor core, coolant, and reflector materials were examined for possible use in the booster. (auth)

**31198** (GA-8847) A BENCHMARK STUDY OF ZPR-III ASSEMBLY 48 USING ENDF/B CROSS SECTIONS. Sargis, D.; Baxter, A.; Archibald, R. (Gulf General Atomic, Inc., San Diego Calif.). Aug. 22, 1968. Contract AT(04-3)-167. 31p. Dep. CFSTI.

A study of the fast critical reactor ZPR-III Assembly 48 has been performed using ENDF/B cross sections. Minor alterations of the ENDF/B data were made to conform with the format requirements of the cross section preparation programs. A comparison was made of experimental and calculated results for various integral quantities, including central reactivity worths, fission and capture ratios, and Doppler and sodium-void coefficients. The comparison indicated some possible areas of uncertainty in the basic cross section data. Real and adjoint neutron spectra were also computed for comparison with calculated and measured results. 5 references. (auth)

**31199** (ORNL-TM-2565) EXPERIMENTAL DETERMINATION OF THE DIFFERENTIAL FAST NEUTRON FLUX IN THE HIGH FLUX ISOTOPE REACTOR USING THRESHOLD DETECTORS. Dodds, Harold Lebron Jr. (Oak Ridge National Lab., Tenn.). May 1969. Contract W-7405-eng-26. 141p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

The differential fast neutron flux above 0.5 MeV at one spatial position in the High Flux Isotope Reactor is determined experimentally using several threshold activation detectors. The series expansion technique utilizing the concept of least squares is used to obtain an approximate solution to the set of integral equations which are defined by experimentally determined activation data. The results which are presented include several different sets of activation data so that the effect of discrepancies in the experimental measurements on the computed differential flux spectra may be observed and evaluated. 37 references. (auth)

**31200** (ORNL-TM-2600) BULK SHIELDING FACILITY QUARTERLY REPORT, JANUARY-MARCH OF 1969. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). May 7, 1969. 101p. Dep. CFSTI.

The BSR operated at an average power level of 1943.5 kw for 75.7% of the time during January, February, and March of 1969. Water quality control in both the reactor primary and secondary cooling systems was very satisfactory. There were four unscheduled shutdowns, all caused by shim rods dropping; two were caused by the No. 4 shim rod, one by No. 1 shim rod, and one by No. 2 shim rod. Minor troubles experienced in the nuclear and process instrumentation were as follows: failure of three composite amplifiers and one magnet amplifier; one shim-rod seat switch failure; failure of two shim-rod-clutch switches; failure of the slip coupling on the north cooling fan; failure of a condenser in the pH indicator for the secondary water cooling system; and failure of the No. 1 safety chamber. (auth)

**31201** (ORNL-TM-2606) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT, JANUARY-MARCH OF 1969. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). May 5, 1969. 22p. Dep. CFSTI.

Operation of the High Flux Isotope Reactor for the quarter January 1 through March 31, 1969, is summarized. Reactor operation was routine and an operating time percentage of 90% was achieved despite the installation of two major experiments into the reactor and the subsequent failure of one of them. (auth)

**31202** (TRG-Report-1754) IMPROVEMENTS IN DOSIMETRY FOR EXPERIMENTS IN DIDO-TYPE MATERIALS TESTING REACTORS. Etherington, E. W. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). Nov. 28, 1968. 19p. Dep. CFSTI. UK 2s. 6d.

Radiation doses for experiments in materials testing reactors are normally measured in terms of the $^{58}$Ni(n,p)$^{58}$Co reaction and the gamma heating rates in a material such as Al or graphite. The effectiveness of such dosimeters is critically assessed for two types of experiment: radiation damage in metals, and aqueous radiation chemistry. A number of suggestions are made for improving dosimetry measurements. 13 references. (auth) (UK)

**31203** HISTORY OF THE NORSE-NETHERLANDS COOPERATION IN THE AREA OF NUCLEAR ENERGY. Goedkoop, J. A. RCN (Reactor Cent. Ned.) Meded., No. 30, 1-228(1968). (In Dutch).

A history is given of the development and results of the Norse-Netherlands collaboration on nuclear energy research. This collaboration began in 1951 and resulted in the JENER, JEEP, and NUPOP reactors. The two agreements between the governments are reported in detail, and the negotiations for a third agreement are described. (J.S.R.)

**31204** EFFECTIVENESS OF DELAYED NEUTRON YIELD OF THE UTR-KINKI. Nakamura, Katsuichi; Tanaka, Hiroshi

(Kinki Univ., Osaka). Kinki Daigaku Genshiryoku Kenkyusho Nenpo, No. 6, 5-8(1967).

Effectiveness of delayed neutron yield of the UTR-Kinki were measured by means of substitution method. As the excess reactivity of the reactor was about 0.15% δk/k, the substitution of a fuel plate brings the reactor to a large subcriticality. Then a "base plate," which is a spare fuel plate containing smallest mass of $^{235}U$ among all plates, was replaced by a suitable fuel plate of the reactor core together with the poison equivalent to the mass difference of $^{235}U$ between these two plates. The poison used was Pb–Cd alloy which was made as having the same absorption cross section of the fuel. The reactivity differences were measured by means of positive period method. As the result, we got the effective delayed neutron yield of the UTR-Kinki as follows, $\beta_{eff}$ = 0.00667, and effectiveness is 1.04. (auth) (NSA of Japan)

**31205** ON HEAVY-WATER CRITICAL ASSEMBLY. Sakata, Hajime (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 11: 301-6(May 1969). (In Japanese).

A brief description is given of the structure of the heavy-water critical assembly (DCA) and of plans for reactor physics experiments. This assembly is utilized to obtain experimental data on physical problems of highly heterogeneous and plutonium fuel loaded systems for the advanced thermal reactor (ATR), now being developed as part of the national power reactor development program in Japan. The particular aims of the DCA include the realization of an experimental bare core and enhancement of the accuracy of experiments. The DCA is now under construction, and is due to be critical December of 1969. 6 references. (auth)

**31206** DISCREPANCY BETWEEN CALCULATED AND EXPERIMENTAL VALUES OF PROMPT NEUTRON LIFE TIME OF FCA FAST ASSEMBLIES. Hiraoka, Toru; Nakano, Masafumi; Mukaiyama, Takehiko (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 6: 290-1(May 1969).

The prompt neutron decay constant at delayed critical was measured by both pulsed neutron and Rossi-α methods on three different fast assembly configurations. Values calculated by a one-dimensional multigroup code are smaller than the experimental values by more than 30%. The measured and calculated values are tabulated and some possible causes of the discrepancies are discussed. (H.D.R.)

**31207** DETERMINATION OF THE LUMPED HEAT-TRANSFER AND REACTIVITY COEFFICIENTS OF A RESEARCH REACTOR. Obeid, M.; Lapsley, A. C. (Univ. of Virginia, Charlottesville). J. Nucl. Energy, 23: 171-81(Apr. 1969).

A method of determining the lumped heat-transfer coefficient and the temperature coefficients of reactivity of a nuclear reactor is presented. No knowledge of the component temperatures is required. The method is thus particularly attractive in systems where temperatures cannot be monitored, or where uncertainties in temperature variations can produce large errors in experimental results. A mathematical model is developed for the reactor, which is assumed to consist of lumped fuel, moderator, and reflector regions. Simplified forms of this model are also developed: a two-region model for fuel and moderator, and a one-region model for fuel only. The equations for these models are expressed as functions of the feedback response of the reactor. The high frequency feedback response is normally a function of only the fuel temperature coefficient of reactivity and the heat-transfer capability from the fuel. The experimental high frequency response characteristic can thus be applied to the one-region mathematical model to determine the fuel reactivity coefficient and the heat-transfer capability. In a similar manner, the experimental medium frequency response of the reactor permits a determination of the fuel and moderator feedback coefficients, and the low frequency response the determination of the reflector coefficients. The model was applied to a swimming pool reactor, with the frequency response measured with a pile oscillator over the frequency range 0.03 to 150 radians/sec. Excellent agreement was obtained between the mathematical model and the experimental response over the entire frequency range. (auth) (UK)

**31208** INFLUENCE OF THE VOID ON SPECTRAL INDICES AND FAST FISSION RATIO IN HEAVY WATER LATTICES. Conti, F.; Maracci, G.; Rustichelli, F. (CCR–EURATOM, Ispra, Italy). J. Nucl. Energy, 23: 157-70(Apr. 1969).

The effect of the void on the thermal and epithermal neutron spectrum indices and on the fast fission ratio was measured in the EURATOM critical facility ECO by means of detector activation and the back-to-back fission chamber technique. Several irradiation measurements were performed on UC and U metal fuel clusters. As coolant the organic liquid diphenyl (eutectic mixture $C_{12}H_{10}-C_{12}H_{10}O$) or air were used. The experimental results obtained are discussed, particularly those reacting to the void differential effect. (auth) (UK)

## Rocket and Space Reactors

*Refer also to abstracts 29039, 29113, 29547, 29965, 30041, and 30602.*

**31209** (LA-DC-10116) ROVER FUEL ELEMENT THERMAL STRESS EXPERIMENTS AND ANALYSES. Rowley, John C.; Lawton, Robert G.; Prince, William R. (Los Alamos Scientific Lab., N. Mex.). [nd]. 13p. Dep. CFSTI.

From AIAA 5th Propulsion Joint Specialist Conference, Colorado Springs, Colo.

The power-density and thermal-stress limitations of Rover reactor fuel elements are analyzed. Measurements are made on graphite elements loaded with pyrocarbon-coated $UC_2$ beads (bead-loaded). Thermal-stress experiments and analyses are also presented for graphite fuel elements having increased thermal expansion and for metal carbide–carbon composite fuel elements. (auth)

**31210** (N-69-20828) PERFORMANCE OF THE SNAP-8 LUBRICATION AND COOLANT SUBSYSTEM. Block, H. B.; Kruchowy, R.; Gallagher, J. D. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1969. 29p. (NASA-TM-X-1731). CFSTI.

A SNAP-8 system containing all major prototype components except the nuclear reactor and the radiator was assembled and tested for 1445 hours at Lewis Research Center. The overall system consisted of five subsystems. One subsystem lubricated and/or cooled the other four SNAP-8 subsystems. Lubrication and coolant subsystem pump parameters, and component endurance data were examined. Data indicated no degradation in pump performance during the test. Fluid was supplied to the SNAP-8 components at the required flow rate and temperature. None of these components experienced a failure or significant degradation caused by lack of lubrication or cooling. Proper cooling of the Hg pump and the turbine alternator space seals resulted in a very low oil and Hg leakage to the space vacuum simulator. (auth) (STAR)

**31211** (N-69-20868) PERFORMANCE OF AN EXPERIMENTAL SNAP-8 POWER CONVERSION SYSTEM. Macosko, Robert P.; Hanna, William T.; Gorland, Sol H.; Jeffries, Kent S. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1969. 30p. (NASA-TM-X-1732). CFSTI.

A SNAP-8 experimental power system was operated for 1445 hours over a time span of 1463 hours. Approximately 1100 hours of continuous system operation were achieved. Steady-state system performance did not degrade with time. All SNAP-8 prototype components performed satisfactorily throughout the test with the exception of the parasitic load resistor. Three automatic shutdowns occurred during the course of the test. The automatic protective system employed functioned properly. There was no oil contamination of the mercury loop as a result of the shutdowns. (auth) (STAR)

**31212** (N-69-20913) RESULTS OF ENDURANCE TESTS OF A SNAP-8 TURBINE-ALTERNATOR. Asadourian, Armen S.; Frye, Robert J.; Macosko, Robert P.; Vernon, Richard W. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1969. 20p. (NASA-TM-X-1741). CFSTI.

The SNAP-8 turbine-alternator was tested with Hg vapor in a system endurance run. Considerable long term endurance and performance information was obtained. The turbine-alternator accumulated 1445 hours (1110 hr continuous) and was subjected to four starts and stops. During the test period, the electrical power output ranged between 36.8 and 45.6 kW. Prolonged operation of the turbine-alternator did not reveal any degradation in performance or operating characteristics. (auth) (STAR)

**31213** PROPULSION FOR BOOSTERS AND SPACE VEHICLES. Reichel, Rudolf H. (VDI, Bellevue, Wash.). VDI (Ver. Deut. Ing.) Z., 111: 508-13(Apr. 1969). (In German).

General trends of development are described for chemical rocket propulsion, nuclear rocket propulsion, and electric space propulsion. 74 references. (auth)

**31214** NUCLEAR-THERMAL ROCKETS. Morrissey, J. E. (Stanford Univ., Calif.). Kerntechnik, 11: 152-8(Mar. 1969).

Design requirements for nuclear powered rockets are discussed. Technologic problems in developing rocket reactor systems are outlined. Materials and control systems requirements

are described. Engine and rocket performance are shown graphically. Gas core concepts are considered briefly. (M.L.S.)

**31215** NUCLEAR POWER SUPPLIES FOR SPACE. Polak, Henri (North American Aviation International Inc., Brussels). pp V.5.1-12 of Progresso Spaziale. I Programmi Spaziali nel Prossimo Decennio. Roma, XV Rassegna Internazionale Elettronica, Nucleare, e Teleradiocinematografica, 1968.

From 8th International Conference on the Technical Societies on Space, Rome, Italy. See CONF-680457.

A historical summary of the Systems for Nuclear Auxiliary Power (SNAP) programs is presented, and SNAP reactor systems development and operating experience are tabulated. The current state of the art in both reactor and radioisotope space power systems is reviewed, and future development trends for space power sources are discussed. (H.D.R.)

## Process Heat and Desalination Reactors

*Refer also to abstract 28945.*

**31216** (ORNL-NDIC-5) INDEXED BIBLIOGRAPHY OF NUCLEAR DESALINATION LITERATURE-3. Johnsson, K. O. (Oak Ridge National Lab., Tenn.). May 1969. Contract W-7405-eng-26. 55p. Dep. CFSTI.

Abstracts are given for approximately 200 published articles related to the desalination of seawater. The body of the bibliography is a copy of information stored in a computerized storage and retrieval system for the Nuclear Desalination Information Center (NDIC) at the Oak Ridge National Laboratory. The abstracts are grouped in nine categories (and repeated if they fall into more than one category). An author and a keyword index to the articles referenced is provided. The keywords, which identify the content of the articles, were chosen from a thesaurus developed by NDIC. (auth)

**31217** DESALTED SEAWATER FOR AGRICULTURE: IS IT ECONOMIC? Clawson, Marion; Landsberg, Hans H.; Alexander, Lyle T. (Resources for the Future, Inc., Washington, D. C.). Science, 164: 1141-8(June 6, 1969).

The economic feasibility of desalting seawater on a large scale for commercial agriculture in regions of extremely low rainfall is examined. It is concluded that the true costs of the proposed desalting projects, now and for the next 20 years, are at least one order of magnitude greater than the value of the water to agriculture. (H.D.R.)

## Marine and Portable Power Reactors

**31218** STRESS MEASUREMENTS ON THE SHELL OF A HEAT EXCHANGER. Wentzel, H. C. Atoomenergie Haar Toepass., 11: 77-83(Mar. 1969). (In Dutch).

A description is given of the development of a steam generator superheater constructed for the NERO ship reactor design. (tr-auth)

**31219** APPLICATION OF WATER-MODERATED AND COOLED REACTORS IN SMALL NUCLEAR POWER PLANTS. Zhil'tsov, V. A.; Kotov, A. P.; Merzlikin, G. V.; Nikul'shina, V. M.; Sergeev, Yu. A.; Sinev, N. M.; Sukhoruchenkov, N. V. At. Energ. (USSR), 26: 403-10(May 1969). (In Russian).

Technical and economical premises and specificity of using small nuclear power plants for power and heat production in remote locations of the USSR are discussed. Some results of operation of the Soviet and foreign small power plants with water moderated and cooled reactors are given. A brief description of the advanced APS "Sever" design with water moderated and cooled reactor ABW-1,5 is represented. The main peculiarities of the reactor ABW-1,5 are the following: arrangement of the core and the steam generator in the same vessel, natural circulation of the coolant in the primary and secondary circuits, power selfregulation on account of negative temperature reactivity effect. The possibility of creating a series of water moderated and cooled reactors of ABW-1,5 type for small power plant and of using such reactors only for heat production are discussed. 14 references. (auth)

## Reactor Theory

*Refer also to abstracts 31081, 31127, and 31157.*

**31220** (AECL-2593(Suppl.)) A DETERMINATION OF LATTICE PARAMETERS USING A FEW RODS. Corrigendum. Okazaki, A.; Craig, D. S. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1969. 4p. Dep. CFSTI. CAN $0.20.

The Persson method of analysis of substitution measurements was previously applied incorrectly and the conclusion stated about the accuracy of this method is not valid. Dr. Persson has kindly analyzed the data using his SIMBA code and the results are presented. These results show that the Persson method gives as good agreement with the bucklings obtained by flux mapping as does the MICRETE method. (auth)

**31221** (AI-AEC-Memo-12756) IMPROVED CALCULATION OF EFFECTIVE RESONANCE CROSS SECTIONS FOR FAST SPECTRUM ASSEMBLIES. Otter, J. M. (Atomics International, Canoga Park, Calif.). Nov. 5, 1968. 12p. Dep. CFSTI.

Modifications to the unresolved resonance subroutine in the TRIX code are described in both theoretical and practical detail. The effects dealt with include depletion of group fluxes by resonance absorption, and the energy dependencies of the absorber potential scattering cross section and level spacing. Also included are the value of the radius of the centrifugal potential well, elastic scatter with change of neutron angular momentum, and Doppler-broadened self-shielded scattering cross sections. Calculations of infinitely dilute cross sections of $^{238}U$ are compared with optical model calculations and good agreement found. 8 references. (auth)

**31222** (LA-4072) ALTERNATE DIRECTION, DISCRETE ORDINATES METHOD. Carlson, Bengt G. (Los Alamos Scientific Lab., N. Mex.). Nov. 1968. Contract W-7405-eng-36. 7p. Dep. CFSTI.

A means for combining discrete ordinates techniques for solving the neutron transport equation with an alternating direction form of iteration is developed. It is based on a transformation of the equation, and is meaningful in geometries of more than one space dimension. This method, abbreviated ADDO, has some advantages, at least in theory, probably also in practice, over the currently used discrete ordinates procedures, typified by the DDF code. No numerical comparisons are available yet. (auth)

**31223** (RPI-328-148) PROGRESS REPORT [ON LINEAR ACCELERATOR PROJECT], OCTOBER 1, 1968-DECEMBER 31, 1968. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. 54p. Dep. CFSTI.

Separate abstracts are prepared for the five separate sections on: neutron cross sections; fast reactor physics-experimental; reactor physics-theoretical; low energy neutron inelastic scattering; and instrumentation development. (M.L.S.)

*For abstracts of individual sections see: 29252, 30912, 30998, 31224, and 31233.*

**31224** (RPI-328-148, pp 27-38) REACTOR PHYSICS: THEORETICAL. (Rensselaer Polytechnic Inst., Troy, N. Y.).

An analytical model for representing fast reactor spectra is described; multigroup and analytic fluxes >0.1 keV or a 9:1 oxide core are tabulated; values for integral capture and fission are given; elastic removal cross sections for Fe are listed. Application of finite difference methods with Green's function modes to flux tilting problems is discussed; the first four eigenvalues of the unperturbed mode are listed. Effects of large time step changes on neutron flux stability and effects of decreasing spatial mesh-spacing on the convergence of the neutron flux are shown graphically. (M.L.S.)

**31225** (TID-25062) APPROXIMATE SOLUTION OF THE XENON-TRANSIENT PROBLEM BY A MODAL EXPANSION TECHNIQUE. Stewart II, John Woods (Tennessee Univ., Knoxville). Mar. 1969. 125p. Dep. CFSTI.

Thesis.

Nuclear power reactors now being designed for construction in the United States are capable of sustaining spatial power oscillations due to the presence of Xe and $I_2$ as fission products. A mathematical and physical description of these reactors is presented. Pertinent previous methods of solution to the Xe-transient problem are presented. An extensive list of references is included. A numerically practical method of solution to the Xe transient problem is presented. This method uses a model expansion of the multienergy group neutron fluxes in multi-dimensions. The model is capable of treating nonlinear feedback and spatially dependent control action. A variational principle is applied to obtain matrix equations for the modal coefficients. The results of a numerical demonstration are included. This demonstration utilizes the quasi-static flux approximation in one- and two-dimensional, rectangular geometry, with two neutron energy groups. The spatial modes chosen for this demonstration

are the Green's functions modes. An asymmetric perturbation is introduced and controllers are ganged to maintain criticality at constant power. These results are compared with the results obtained from a spatial finite difference solution. The results indicate that the modal expansion model is capable of treating large spatial transients. 128 references. (auth)

**31226** REFLECTOR SPECTRUM CALCULATION. Girgis, R.; Karchava, G.; Hamouda, I. (Atomic Energy Establishment, Cairo). J. Nucl Energy, 23: 183-4(Apr. 1969).

The reflector spectrum of the UA-RR-1 reactor ($H_2O$ moderator, coolant, and reflector) was calculated by a modification of Perkin's method. The $P_1$ approximation was replaced by an approximation based on the application of the Goertzel–Greuling kernel to the treatment of the slowing down equation for a two-component moderator. This method resulted in a much simpler formula which yielded almost the same spectral curves. (UK)

**31227** ANALYSIS OF THE ROSSI-$\alpha$ EXPERIMENT THROUGH PAL–BELL'S EQUATION. Izumi, Akira (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo), 6: 248-60(May 1969).

Pál–Bell's equation for the probability generating function of neutron counts has been analytically solved in the case of three time states, using two-forked approximation. From this solution it is found that all experimental data on neutron fluctuation consist individually of only three basic parameters. The average counting rate C, the decay constant $\alpha$ and the chain register rate $C_r$ are in this instance chosen for the three fundamental measures of correlation. The original observation is presented that $C_r$ can be obtained precisely by determining the waiting time distribution for the triggering of the time analyzer. The correlated and uncorrelated parts of the Rossi-$\alpha$ data in a thermal system have been analyzed by this three-parameter scheme, and a consistent explanation is given of the results obtained. (auth)

**31228** MARKOFFIAN DESCRIPTION OF AT-POWER REACTOR NOISE. Saito, Keiichi (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 6: 261-72(May 1969).

A new formulation of the noise spectra in at-power reactors is presented. Input noise source is determined in such manner that ready comparison is possible between the square modulus of the reactor transfer function and the noise spectrum. The physical meanings of the noise-equivalent source are clarified. A new noise source additional to that of zero-power reactors is found, which results in a non-white contribution to the input noise source spectrum. The basis of the theory is a set of macrostochastic variables characterizing the state of the reactor possesses Markoffian property. Three types of reactions are taken into account—source emission, linear and bilinear reactions. (auth)

**31229** EQUIVALENCE RELATION BASED ON AN IMPROVED RATIONAL APPROXIMATION. Chiarella, C.; Keane, A. (Wollongong University Coll., Australia). J. Nucl. Sci. Technol. (Tokyo), 6: 273-8(May 1969).

The equivalence relation between heterogeneous and homogeneous reactor systems was first established by Chernick & Vernon by using the rational approximation for the collision probabilities. Refinements have been introduced into the rational approximation. The parameters introduced are evaluated by separate considerations and are shown to be related to the Dancoff & Bell factors. Narrow resonance considerations are invoked since partial neglect of scattering complicates the issue being studied. (auth)

**31230** OPTIMAL CONTROL OF ZENON DOMINATED REACTOR SHUTDOWN. Gow, R. S. (Central Electricity Generating Board, Dungeness, Eng.). J. Brit. Nucl. Energy Soc., 8: 109-15(Apr. 1969).

Modern control theory was applied to the problem of reactor shutdown. The performance criterion chosen was minimum time for part load operation with restart capability continuously available, so that Xe poisoning was avoided. Suitable ratings and reactivity inventories based on typical Magnox and AGR data were chosen for illustration. (auth)

### *Experimental Applications*

*Refer also to abstract 31207.*

**31231** (BNWL-1002) ETOX: A CODE TO CALCULATE GROUP CONSTANTS FOR NUCLEAR REACTOR CALCULATIONS. Schenter, R. E.; Baker, J. L.; Kidman, R. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1969. Contract AT(45-1)-1830. 54p. Dep. CFSTI.

Computer code ETOX (ENDF/B TO 1DX) calculates group constants for reactor calculations from currently available nuclear data. The code is specifically designed to use the Evaluated Nuclear Data File (ENDF/B) as input for microscopic cross section values. Output from this code includes punched cards in the Bondarenko format which can be used as input to the fast reactor codes FCC-IV and 1DX. Running time on a UNIVAC 1108 computer ranges from 13 to 600 sec per isotope. The current version of ETOX is restricted to a maximum of 99 energy groups. 10 references. (auth)

**31232** (JUL-547-RG) MEASUREMENT OF THE FAST FISSION FACTOR OF BERYLLIUM OXIDE WITH HELP OF THE MANGANESE SULFATE BATH TECHNIQUE AND A CADMIUM LOADED LIQUID SCINTILLATOR. Kirch, Norbert (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Aug. 1968. 75p. (In German). Dep.

Two research installations for the measurement of the fast fission factor of BeO were described. The fast fission factor resulted from the comparison of the counting rate of a $^{252}Cf$ fission neutron source in BeO samples and in non-multiplying samples of graphite and heavy water. The first installation, the manganese sulfate bath, showed, because of the 300-eV resonance, a slightly energy-dependent response and was therefore not completely suitable for the detection of the neutrons leaving the samples. For small BeO samples up to 7 cm radius, the energy dependence could be eliminated by comparison with different sized graphite samples and with a heavy water sample. For the largest BeO samples, such a corrector was only poorly possible because of the partial thermalization of the neutrons leaving the sample. Because of the relative low absorption cross section of the manganese sulfate solution, there was a high thermal neutron flux in the samples which led to absorptions in the sample material. These corrections were the highest for the largest samples and these corrections therefore had the largest error. In the second installation, the cadmium-loaded scintillation tank, these corrections dropped because of the significantly higher poisoning of the liquid. This installation was very suitable for the detection of neutrons in a wide energy region with constant probability. More accurate results are also obtainable with this method than with the manganese sulfate bath. Within the limits of error the values of both methods agree. The fast fission factor of an infinite expanding BeO system was extrapolated from BeO samples with 7 and 9 cm radius. The two methods gave the value $\epsilon_{BeO} = 1.048 \pm 0.004$. (tr-auth)

**31233** (RPI-328-148, pp 18-26) FAST REACTOR PHYSICS: EXPERIMENTAL. (Rensselaer Polytechnic Inst., Troy, N. Y.).

Measurement of fast neutron distributions in an iron assembly is discussed; spatial relaxation of neutrons of selected energies in the zero-degree direction is shown. Effects of magnitude of re-entrant hole perturbation are summarized; data are shown graphically. (M.L.S.)

**31234** (TRG-Report-1761) SQUIFID: A SQUARE-MESH FEW-GROUP REACTOR DIFFUSION CODE. McCallien, C. W. J. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Sept. 19, 1968. 54p. Dep. CFSTI. UK 7s. 6d.

SQUIFID is a FORTRAN 4 program that solves the few-group neutron diffusion equations. Using a square mesh, the program can solve the conventional or homogenised diffusion equations in which the properties of a fuel channel are smeared out over a mesh area. Alternatively, the source-sink equations appropriate to a graphite moderated reactor with cylindrical channels on a square lattice can be solved. Some features of SQUIFID which make it attractive as a means of solving the homogenised equations are the ability to treat whole-cores, half-cores, quadrants, or octants with either a channel position or an interstitial position coinciding with the reactor core's center. For such calculations the flux may vanish on an outer boundary that may be either circular or polygonal in shape. Rectangular supercells with cyclic, reflective, or zero-flux outer boundaries can also be treated. A facility is available whereby account can be taken of weak interstitial rods without making the total number of unknowns greater than the number of groups times the number of reactor cells (including pure reflector cells). 6 references. (UK)

## Reactor Components, Fuels, and Accessories

*Refer also to abstracts 28718, 29022, 29085, 29115, 29121, 29127, 29143, 29255, 29268, 29952, 29961, 29988, 30006, 30010, 30012, 30021, 30100, 30108, 30109, 30121, 30123, 30124, 30127, 30129–30133, 30136, 30139, 30144, 30161, 30198.*

**31235** (BNL-13627) SURVEY OF NUCLEAR MATERIAL AND POSSIBLE MEASUREMENT TECHNIQUES. Higinbotham, W. A.; Court, A. (Brookhaven National Lab., Upton, N. Y.). Apr. 29, 1969. 22p. (CONF-690411-2). Dep. CFSTI.

From 10th Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nev.

The material accountability program for safeguards purposes depends on measurements which presently consist of destructive analyses, i.e., taking of samples which then are measured in an analytical laboratory. For inventory verification and special surveys some use is made of gamma ray analysis. The USAEC, the International Atomic Energy Agency, and other institutions are now supporting development of a variety of passive measurement techniques which may supplement or replace the destructive measurements currently employed. The amounts and types of material which will exist during the next five years at various points in the nuclear fuel cycle in US privately owned facilities are described and the types of measurement techniques (destructive or non-destructive) that may be applicable at each point are indicated. (auth)

**31236** (BNWL-1039) PLUTONIUM UTILIZATION PROGRAM. Technical Activities Quarterly Report, December 1968-February 1969. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1969. Contract AT(45-1)-1830. 78p. Dep. CFSTI.

CRITICALITY STUDIES—measurement of heavy water cooled and moderated 31 and 55 element cores, (E/T)
NEUTRONS, EPITHERMAL—spectra in water cooled and moderated systems, upscattering corrections for, (T)
PLUTONIUM ISOTOPES—concentration in Yankee Power Reactor fuel, effects of burnup on
PLUTONIUM OXIDES $PuO_2$—$PuO_2$–$UO_2$, fuel elements of, effects of specific power and burnup on defect behavior of vibrationally compacted
PLUTONIUM RECYCLE CRITICAL FACILITY—neutron flux peaking and dipping in 13 element core of, gold foil activation analysis of
—neutron noise in heavy water moderated plutonium oxide ($PuO_2$)–uranium oxide ($UO_2$) 19 rod cluster, (E/T)
—control element of, reactivity worth measurements for
PLUTONIUM RECYCLE TEST REACTOR—fuel element testing in, status of high power density plutonium oxide ($PuO_2$)–uranium oxide ($UO_2$)
—kinetic parameters of heavy water cooled and moderated 31 and 55 element cores in, (E/T)
—operations during December 1968 to February 1969
RADIATION DETECTORS, FISSION FOIL—use of gold foil, for measurement of neutron flux peaking and dipping in PRCF 13 element core
—use of indium foil, for neutron flux measurement comparisons with boron fluoride ($BF_3$) proportional counter
RADIATION DETECTORS, PROPORTIONAL—use of boron fluoride ($BF_3$), for neutron flux measurement comparisons with indium foil
REACTOR CONTROL ELEMENTS—reactivity worth of PRCF
REACTOR FUEL ELEMENTS—defect behavior of vibrationally compacted plutonium oxide ($PuO_2$)–uranium oxide ($UO_2$), effects of specific power and burnup on
URANIUM OXIDES $UO_2$—$PuO_2$–$UO_2$, fuel elements of, effects of specific power and burnup on defect behavior of vibrationally compacted
YANKEE POWER REACTOR—fuel burnup in, analysis of plutonium concentration from (D.C.C.)

**31237** (CONF-681058-1) COMPUTERS IN NUCLEAR PLANT SIMULATION. Rosser, R. M. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Oct. 1, 1968. 29p. (TP-8-40).

From Forum of the Computer Task Force of MEEAC of the Edison Electric Institute, New York.

The use of analog, digital, and hybrid computers for training operators of nuclear reactors is described. Topics discussed include: philosophy of simulator training; analysis and development of design requirements; selection of hardware configuration; potential problem areas; division of responsibility; current economic factors and trends; and comments on specific simulators. (D.C.C.)

**31238** (CONF-690113-3) ELECTRICAL PENETRATORS FOR NUCLEAR REACTOR CONTAINMENT VESSELS: WIRE TERMINATION TECHNIQUES AND FAULT CURRENT DETERMINATIONS. Hagmann, R.; Dunn, D. L. (Viking Industries, Inc., Chatsworth, Calif.). Sept. 17, 1968. 7p. IEEE $1.00.

From IEEE Winter Power Meeting, New York.

Nuclear penetrator history is described. The design criteria and requirements currently being proposed relating to the manufacture of nuclear containment structure electrical penetrators are reviewed. Problems which have required solutions in order to arrive at the present state of the art "third generation" penetrator devices are analyzed. A discussion of fault current requirements which, at this time, are under further intensive investigation and test is presented. Firmly established criteria for fault testing are not available. Current penetrator design in this area is predicted on somewhat arbitrary values of fault currents which have been extended from the magnitudes relating to the associated switchgear and protective devices. Various other design and operating parameters are also covered which have been found to be of importance in penetrator design. (auth)

**31239** NUCLEAR REACTORS. Moir, Donald Alexander; Beasley, Philip Charles (to English Electric Co., Ltd.). British Patent 1,151,777. May 14, 1969. Filed Nov. 1, 1966.

Reference is made to reactor charge chute assemblies which provide a path between a single access duct and, selectively, any of a multiple of openings arranged in groups, each on a different pitch circle and having a common axis with the access duct. The body portion incorporates an operating mechanism comprising a drum-type cam coaxial with the common axis and restrained from rotation. A lever means, which is connected with a hollow open-ended leg pivoted at an intermediate point on the body portion, has a cam follower. By simple rotation of the body portion the lever means is guided by the cam so as to move the leg between radial positions. Various designs of drum cam and lever means are described. (UK)

**31240** PROFILE, THICKNESS, AND INTERNAL DIAMETER MEASUREMENTS ON FINNED STEEL TUBING USING AN ON-LINE COMPUTER. Wells, F. H.; Davey, C. N. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 92-5 of Conference on Industrial Measurement Techniques for On-line Computers, London, 11th-13th June, 1968. London, Institution of Electrical Engineers, 1968.

See CONF-680653.

The equipment described is being used for measuring the dimensions of the stainless steel tubing which is employed for "containing" the uranium fuel in a Nuclear Power Reactor. It is essential to measure all parts of this high quality tubing to ensure that no faults in manufacture or flaws in the metal are present in the finished product. The dimensions to be measured are the cooling fin profile shapes, the thickness of the tubing wall in between fins, and the internal diameter; metallurgical measurements of flaws in the metal and grain size are performed on other equipments. These measurements are made on every fin (about 500 on each tube) and many hundreds of thousands of such tubes must be measured at a rate of 30 per hour, if possible. The inference is that the measurement equipment must be as fully automated as possible, unless it can be shown that fewer measurements will still give an acceptable quality. The latter argument is unlikely, so that it was decided to design the described automated inspection equipment. (UK)

**31241** CALCULATION OF REACTIVITY WORTH OF A CONTROL ROD ARRAY. Makino, Kakuji (Tokyo Shibaura Electric Co.); Fukai, Y. J. Nucl. Energy, 23: 187-204(Apr. 1969).

A new method of calculation of the reactivity worth of a linear array of stainless steel clad $B_4C$ control rods is presented. The method is based on an exact treatment by the collision probability method of the control rod region and its vicinity and on diffusion theory in the region far from the control rods. Slab approximations are shown to lead to significant error. Using the proposed method calculation by ALAX, a GE-635 code in the elaborate GMAP language, requires a very short computing time: 1.5 min per case for a four-group calculation. (UK)

**31242** SUMMARY SURVEY OF DETECTION AND LOCATION OF FAILED FUEL ELEMENTS. Mochizuki, Keiichi (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Nippon Genshiryoku Gakkaishi, 11: 279-91(May 1969). (In Japanese).

A general survey is presented on the detection and location of failed fuel elements. Three major methods are reviewed: direct measurement of $\beta$ and $\gamma$ activities of fission products, delayed neutrons and precipitation. For the location of failed elements, the normal sampling method and also other new approaches, such as by neutrons flux tilting, are covered, with particular reference to utilization in fast breeder reactors. The review further extends to non-destructive methods for detecting spent fuel failure. A discussion is given on detection sensitivity, as well as points to be considered in the design of detecting and locating systems. 33 references. (auth)

# GENERAL

**31243** (AEC-tr-6931/1) NUKLEONIKA. Translation of Nukleonika, 13: No. 1, 1-130(1968). 130p. (TT-68-50011/1). CFSTI.

**31244** (ANL-7523) THERMODYNAMIC PROPERTIES OF GASEOUS $Ge_2$, $GeF_4$, $GeF_2$, AND GeF. O'Hare, P. A. G. (Argonne National Lab., Ill.). Dec. 1968. Contract W-31-109-eng-38. 18p. Dep. CFSTI.

The thermodynamic functions $(G^0-H^0_0)/T$, $(H^0-H^0_0)/T$, $S^0$, $C^0_p$, $H^0-H^0_{298}$, $\Delta HF$, $\Delta GF$, and log Kf were calculated and are tabulated for $Ge_2$, $GeF_4$, $GeF_2$, and GeF in the ideal gas state at selected temperatures between 0 and 6000°K. (auth)

**31245** (BNWL-1000) TECHNICAL PUBLICATIONS OF BATTELLE-NORTHWEST DURING 1968. Foskett, E. (comp.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1969. Contract AT(45-1)-1830. 46p. Dep. CFSTI.

Formal research and development reports and technical articles published during 1967 by Battelle-Northwest are listed under the following subject categories: biology and medicine; chemistry; earth sciences; effects of nuclear weapons and explosions; engineering; health and safety; instrumentation; isotopes; mathematics and computers; metals, ceramics, and materials; physics; reactor technology; rocket and ramjet propulsion; space applications; and weapon fabrication. An author index and report number index are included. (W.H.K.)

**31246** (CALT-757-3) APPLICATION OF ION CYCLOTRON RESONANCE TO THE STUDY OF ION-MOLECULAR INTERACTIONS. Technical Progress Report, February 1, 1968-December 31, 1968. Beauchamp, Jesse L. (California Inst. of Tech., Pasadena. Arthur A. Noyes Lab. of Chemical Physics). Contract AT(04-3)-757. 38p. Dep. CFSTI.

An ion cyclotron resonance spectrometer was installed. Auxiliary equipment includes a pulsed radiofrequency apparatus, a bridge spectrometer, a metastable beam source, a photoionization source, and an apparatus for studying the beta decay of tritiated species. Ion cyclotron single- and double-resonance spectroscopy were employed to identify and study the kinetics and energetics of ion-molecule reactions. The ionization and ion chemistry of isopropyl alcohol were studied. Proton affinities of organic molecules in the gas phase were investigated. The product distributions from the reactions of $H_3^+$ and $D_3^+$ with a series of hydrocarbon molecules were determined using the pulsed ion ejection technique. The initial distribution and subsequent reactions of the ionic fragments derived from photoionization of 2-butanol were investigated. (M.C.G.)

**31247** (CEA-Bib-135) ANALYTICAL METHODS FOR GASES USING IONIZATION. Toudoire, Bruno (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1969. 29p. (In French). Dep.

After a brief review of the principles of the analytical methods for gases used mainly in gas-phase chromatography, a more detailed description is given of the systems based on ionization; these are principally: the argon detector; the electron capture detector; the flame ionization detector; the mobile electron detector; the ionization cross-section detector; and the combination of a mass spectrometer with an ionization detector. A table is given as an appendix of the principal ionization detectors. A non-restrictive list of patents covering this topic is given. (auth)

**31248** (CEA-R-3522) STUDY OF ACID-BASE PROPERTIES IN VARIOUS WATER-SALT AND WATER-ORGANIC SOLVENT MIXTURES. Lucas, Michel (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1969. 74p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

Acid-base reactions were studied in water-salt mixtures and water-organic solvent mixtures. It was possible to find some relations between the displacement of the equilibria and the numerical value of water activity in the mixture. Some equilibria $H^+ + B \rightleftharpoons HB^+$ in salt-water mixtures were studied and a relation was found between the $pK_A$ value, the solubility of the base and water activity. The reaction $HO^- + H^+ \rightleftharpoons H_2O$ was investigated and a relation was found between $pK_i$ values, water activity and the molar concentration of the salt in the mixture. This relation is the same for every mixture. Then the same reactions were studied in organic solvent-water mixtures. It was possible to explain easily some properties of organic water-mixtures as the shape of the curves of the Hammett acidity function Ho. (auth)

**31249** (CONF-680810-, pp 29-43) ENERGY-INTENSIVE AND HEAT-INTENSIVE PROCESSES FOR A NUCLEAR ENERGY CENTER. Holmes, John M. (Oak Ridge National Lab., Tenn.).

Chemical and metallurgical industries are large energy consumers with increasing power demands and significant sensitivities to changes in electricity prices. The major categories considered for installation at nuclear energy centers include: balanced fertilizers; metals, such as aluminum, iron, steel, and magnesium; plastics; and brine chemicals. Other energy-intensive systems that may show promise include waste-water treatment, electric railways, high-temperature process heating, urban space heating, and several recently developed electroorganic processes. For economic utilization of the power from a 1000-Mw(e) nuclear reactor, a number of the proposed systems would have to be combined into a complex. (auth)

**31250** (CONF-680810-, pp 219-37) SPACE HEATING IN URBAN ENVIRONMENTS. Miller, A. J. (Oak Ridge National Lab., Tenn.).

A preliminary study indicates that in 1980 the heat from a nuclear energy center in or near a large city could be used to heat and to air-condition a large portion of the city at a cost per unit of heat equivalent to that now incurred by district heating in downtown commercial and high-rise apartment areas. The heat used would be from steam out of back-pressure turbines and turbine bleed rather than from prime steam, and thus the waste of heat from the plant generating electricity would be reduced or largely eliminated. Such a system would reduce both chemical pollution of the air and thermal pollution of streams. (auth)

**31251** (CONF-680810-, pp 239-47) APPLICATION OF LOW-COST ENERGY TO PROCESSING OF SEWAGE WATER FOR REUSE. Spiewak, Irving (Oak Ridge National Lab., Tenn.).

Water supply and sewerage systems for a city of 2 million are analyzed. Examples are given of a conventional system, a system using advanced waste treatment, and a system using complete waste-water recycle. Low-cost energy has a significant impact only on the water recycle system, which includes a unique desalting process combining electrodialysis and distillation. Waste solids are distilled to dryness. The cost of the total water system ranges from $\$0.33/10^3$ gal for the conventional system to $\$0.45/10^3$ gal for the water recycle system. (auth)

**31252** (CTC-15) SHOP SCHEDULING WITH KNOWN WORKLOADS. Hawthorne, J. E.; McLaren, R. A. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). May 23, 1969. Contract W-7405-eng-26. 117p. Dep. CFSTI.

A computer program which develops detailed schedules for production machine shops is reported. A shop must satisfy the following two major conditions to be scheduled by the program: workload for the period to be scheduled must be known in advance; and all processing times must be known. These conditions are generally met in shops which operate midway between the typical "jobshop" and a pure production line situation. The variety of products competing for time on common facilities generates the scheduling problem; repetitive production of lot quantities of each product provides the known workloads and processing times. The method of solution is a combination of simple scheduling rules and a predictive heuristic technique. The prime scheduling rule is based on "job slack," a measure of the time remaining before a job must be completed. This rule has proven effective in several investigations. Of more importance is the scheduling of production in one time period based on expected conditions in future time periods. This is the "predictive heuristic." The program has been implemented within the Union Carbide Corporation, Nuclear Division's Production Organization. Enough experience has been gained to indicate that automated scheduling techniques are practical in a real industrial setting, and that they may indeed become necessary as interrelated production activities become increasingly complex. (auth)

**31253** (LA-4086) GENERALIZED TRANSPORT THEORY OF ANISOTROPIC TURBULENCE. Harlow, Francis H.; Hirt, Cyril W. (Los Alamos Scientific Lab., N. Mex.). Jan. 19, 1969. Contract W-7405-eng-36. 19p. Dep. CFSTI.

Turbulence flux approximations, previously used in transport equations for an eddy viscosity function, are used to derive similar equations for the Reynolds stress. Both this and the associated transport equation for scale are written in universal, invariant form for application to a wide scope of time-dependent problems in arbitrary configuration. Several aspects of the derivation are discussed and some properties and solutions of the equations described. (auth)

**31254** (LA-4102) DERIVATION OF ALLOY ACTIVITY EQUATIONS FOR EMF CELLS INVOLVING DISPLACEMENT REACTIONS. Conant, Donald R. (Los Alamos Scientific Lab.,

N. Mex.). Nov. 15, 1968. Contract W-7405-eng-36. 10p. Dep. CFSTI.

Equations were derived for relating cadmium activity to emf measurements obtained from cells of the type:

$$W - Cd|CdX_2||Cd,\ CdX_2,\ M_1|Cd,\ M_1 - W$$

$$a_{Cd} = 1 \qquad a_{Cd} < 1$$

where $M_1$ represents a metal that displaces a significant amount of cadmium in molten halide electrolyte forming ions with a single unit positive charge. Results from the thermodynamics of irreversible processes are used in the development of these equations because of the irreversible flow of cadmium and of $M_1^+$ ions present in this type of cell. The final equation is complex, but, for very dilute alloys, reduces to the form

$$\ln a_{Cd} = \frac{-2F}{RT\left[1 - (u_{M_1^+} N_{M_1X}^{electrolyte}/u_{Cd^{2+}} N_{M_1}^{alloy})\right]} \int_A^B N_{CdX_2}^{electrolyte}\, d\left(\frac{E}{T}\right)$$

where u refers to mobility and N to mole fraction. Equations were also derived that relate emf to $M_1X$ concentration for cells of the type:

$$\begin{matrix} & A & & B & \\ W - Cd,\ M_1|Cd,\ CdX_2,\ M_1X||Cd,\ CdX_2|Cd,\ M_2 - W \end{matrix}$$

$$a_{Cd}^A = a_{Cd}^B$$

where $M_2$ represents a metal that does not significantly displace cadmium. For dilute solutions with $a_{M_1X}$, assumed to follow Raoult's limiting law, the resulting equation is

$$E = \frac{RT}{2\, N_{CdX_2}^{electrolyte}\, F} \frac{u_{M_1^+}}{u_{Cd^{2+}}} N_{M_1X}^{electrolyte}.$$ (auth)

**31255** (MIT-905-133, pp 37-77) INSTRUMENTAL CHEMISTRY GROUP. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science).

Progress is reported on studies concerning chemiluminescence and photoluminescence of ruthenium chelates; decomposition of dibenzal diperoxide; chemiluminescence from peroxide decompositions; electrochemiluminescence of aromatic hydrocarbon; chemiluminescence of lucigenin; chemiluminescence of luminol; fluorescence of 9-anthroic acid and its derivatives; xenon quenching of luminescence; production of singlet oxygen; radio-frequency excitation; triplet-singlet energy transfer; comparative electrochemistry and photochemistry of phenazine in acidic methanol; photochemistry of anthraquinone; photoreduction of benzophenone by amines; mechanistic flash photolysis; an image intensifier spectrography; electron spectroscopy; analysis of surface adsorbed oxygen on solid electrodes; measurement of fluoroborates complex equilibria; complex formation between transition metal ions and globular ligands; anodic stripping voltammetry; and simultaneous analysis of two component mixtures of Al and Ga or In present as their oxine complex. (D.H.M.)

**31256** (MIT-905-133, pp 91-3) PHYSICAL CHEMISTRY GROUP. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science).

Topics covered include determination of vapor-liquid equilibrium by static measurements, the excess free energy and related properties of solutions containing electrolytes, and heats of dilution of electrolyte solutions. (D.H.M.)

**31257** (MLM-1602) DETERMINATION OF As(III) BY CONTROLLED-POTENTIAL COULOMETRY. Bohl, D. R.; Koehler, F. A.; Sellers, D. E. (Mound Lab., Miamisburg, Ohio). May 30, 1969. Contract AT(33-1)-Gen-53. 10p. Dep. CFSTI.

A controlled-potential coulometric procedure was extended for use in the determination of microgram quantities of arsenic. Improved sensitivity and accuracy were obtained by using a small titration cell in conjunction with an electronic solid-state, controlled-potential coulometer (Model 810, Monsanto Research Corporation). Results for twenty-seven As(III) determinations at the 120 to 360 μg level had an average error of +0.19% and a relative standard deviation of ±0.22%. The controlled-potential coulometric procedure for determination of As(III) compares favorably to constant-current coulometric procedures, but the titration endpoint using the controlled-potential method is easily determined without the requirement of special apparatus. (auth)

**31258** (RFP-1259) PLOT: A COMPUTER PROGRAM FOR AUTOMATIC GRAPH PLOTTING. Heiple, Clinton R. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Mar. 14, 1969. Contract AT(29-1)-1106. 60p. Dep. CFSTI.

A computer program, written in FORTRAN IVG for the IBM 360, which generates the instructions necessary to plot graphs on the Gerber Series 2000 plotter is presented. The program can be used to plot virtually any type of two dimensional graph with rectangular axes. Appendices have been included so that future modifications of the program can be made with a minimum of difficulty. (auth)

**31259** (SC-DC-69-1853-A) COMPUTER AIDED PRECISION GRAPHICS. Burd, W. C.; Ristine, T. I.; Thompson, R. E. (Sandia Labs., Albuquerque, N. Mex.). [1969]. 22p. (CONF-690605-1). Dep. CFSTI.

From National Conference of the Association for Precision Graphics, Dallas, Tex.

A speech outline discussing how computerized techniques are utilized in the preparation of precision art work is presented. This outline elaborates on the use of Interactive Computer Graphics as a tool to verify and revise printed circuit masters. (auth)

**31260** (SCL-DR-68-112) MEMBRANE AND EDGE EFFECT SOLUTIONS OF FILAMENT-WOUND SHELLS OF REVOLUTION. Fettahlioglu, Oemer A. (Sandia Labs., Livermore, Calif.). May 1969. Contract AT(29-1)-789. 78p. Dep. CFSTI.

A method for analyzing stresses and displacements in filament-wound shells of revolution is presented. This method of analysis is based on the membrane theory of shells but incorporates the edge effect theory to predict a more realistic behavior in the vicinity of polar openings. In addition, because it includes the contribution of the matrix, the present membrane theory is more accurate for the analysis of shells under nondestructive operating loads than is the so-called netting analysis which considers the filaments to be the only load-carrying members. The membrane theory is also modified to give accurate solutions in the shallow region of composite shells and indicates significant bending stresses due to orthotropy and the shape of the meridian. While these stresses are localized near the apex in thin shells, they may extend well down along the meridian in thick shells. (auth)

**31261** (SRRC-29/69) REPORT ON SESSION 1967/1968. (Scottish Research Reactor Centre, East Kilbride (Scotland)). Feb. 1969. 24p. Dep.

Mass spectrometry is being used to study the effects of reactor radiation on organic materials at short times following radiolysis. Neutron diffraction equipment was modified to study phase changes in β-brass. Measurements of the beta energy released following fission of $^{235}U$ were completed. Errors arising from solubility losses and coprecipitation in the determination of fluorine by precipitation of $CaF_2$ were investigated using radiometric techniques. Approximately 20 consignments of 100 μCi of carrier-free $^{18}F$ were processed for use in tracer studies. Advances were made in resolution and performance of the Wien-type isotope separator. The decay properties of $^{55}Cr$ are being studied. Whole-body monitor calibration for body potassium measurements were studied. A double tracer of vitamin $B_{12}$ absorption was developed. Development of the Isotope Geology Unit is reported. Reactor power increases and operation are discussed. (M.C.G.)

**31262** (TID-25081) THE FEASIBILITY OF DEEP-WELL INJECTION OF WASTE BRINE FROM INLAND DESALTING PLANTS. Research and Development Progress Report No. 432. Boegly, W. J. Jr.; Jacobs, D. G.; Lomenick, T. F.; Sealand, O. M. (Oak Ridge National Lab., Tenn.). Mar. 1969. 76p. GPO $0.75.

Deep-well injection was proposed as a method for disposal of brine effluents from inland desalting plants. A review of pertinent literature reveals that deep-well injection is technically feasible, if satisfactory pretreatment is provided. Industrial waste can be disposed of in this manner for about $1.00 to $2.00 per 1000 gallons. Brine disposal from oil-field operations is less costly, ranging from $0.25 to $0.70 per 1000 gallons, primarily because of the magnitude of the operations and because less extensive pretreatment is required. In order to prevent damage to the receiving formation, it will be necessary to inject waste solution without plugging the formation. This requires that the solution be free of suspended solids and be chemically stable with regard to formation of precipitates. Treatment may also be required to prevent biological growths that can plug the injection face. A suitable site for deep-well injection requires a permeable sedimentary formation, such as sandstone or limestone, capped by an impermeable formation, such as shale, to prevent pollution of neighboring potable waters. Such sequences of formations are most likely to be situated in the closed basins, but suitable sites may be found throughout wide geographic areas of the country. Even when preliminary screening suggests that the general area is highly favorable for deep-well injection, more detailed geologic and hydrologic investigations will be required to assure that the site is satisfactory and to provide data to be used as the basis for designing an injection system. (auth)

**31263** (UCRL-50593) ATMOSPHERIC CONSERVATION EQUATIONS IN FLUX DIVERGENCE FORM. MacCracken, Michael C. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 10, 1969. 22p. Dep. CFSTI.

The equations governing the behavior of the earth's atmosphere are formulated in a flux divergence form which conserves mass, energy, water vapor, and angular momentum. Special attention is paid to the fluxes due to viscous effects through study of the equations of motion for a spherical shell and a disk. It is shown that conservation of angular momentum is achieved by making the diffusive flux proportional to the negative gradient of angular velocity. (auth)

**31264** (UCRL–50610) A BIBLIOGRAPHY ON APPROXIMATE MULTIDIMENSIONAL INTEGRATION, 1960–1968. Fritsch, F. N. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 5, 1969. 20p. Dep. CFSTI.

A bibliography of the literature of approximate multidimensional integration for the years 1960 to 1968 intended to supplement the bibliographies of Stroud is presented. It does not include Monte Carlo methods or numerical integration of functions of a single variable. (auth)

**31265** (UCRL–50623) EVALUATION OF EXPANSION CHAMBERS IN SHOCK-TUBE EXPERIMENTS WITH MASS ADDITION. Richter, Horst P. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 28, 1969. 10p. Dep. CFSTI.

In a previous evaluation of expansion chambers in shock-tube experiments the case of mass addition from the surrounding tube walls was not treated. The flow losses or frictional effects were calculated under the condition that mass did not enter or leave the system through the control surface. Relations are discussed which permit the determination of the amount of mass from the pipe walls that enters the flow of a hot gas. The usefulness of the relations is illustrated by applying them to a shock-tube experiment. These relations are critically compared with the true representation of measurements. Implications to theoretical calculations such as made in the PUFL code are mentioned. The use of the equations for predicting design criteria is outlined. It is again demonstrated that the concept of entropy is useful in the evaluation of measurements. Reference is made to the fact that entropy is also widely used in advanced theoretical calculations because it reduces mathematical complexity. (auth)

**31266** (UCRL–50629) OPTICAL AND SEDIMENTATION STUDIES OF VIRUSES AND THEIR $Hg^{++}$ COMPLEXES. Cheng, Ping-Yao (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 2, 1968. 15p. Dep. CFSTI.

Purified viruses and their complexes with $Hg^{++}$ or propylmercuric ion were studied by optical rotatory dispersion, ultraviolet absorption, and sedimentation velocity techniques. The study was designed to ascertain the conformation of nucleic acid in a nucleoprotein and to determine the dependence on nucleic acid and nucleoprotein structure of the availability of the nucleoprotein bases to the mercurials, and the alterations in the structure of the macromolecule produced by the mercuric ions. The viruses investigated were TMV, TYMV, BSV, SBMV, TRSV, f2, reovirus, and T2. For comparison with the viruses, several viral and cellular RNA were also studied. The dispersion curves of all the RNA viruses had a peak in the first Cotton effect corresponding to their constituent RNA. However, each curve differed markedly from the others in the wavelength region below 270 mμ. The $Hg^{++}$ was bound to TMV at sites other than the RNA bases, apparently without aggregating or degrading the virus particles. The bases of all the other viruses studied remained accessible to $Hg^{++}$, no matter whether the nucleic acid was DNA or RNA, single- or double-stranded. Like $Hg^{++}$, $C_3H_7Hg^+$ was also bound to the bases of TYMV but to other sites of TMV. However, different changes in gross macromolecule structure were observed for different viruses either with $Hg^{++}$ or with $C_3H_7Hg^+$, and for the same virus between $Hg^{++}$ and $C_3H_7Hg^+$. The RNA molecule of TYMV was distorted, probably in the orientation of bases, on being packed into a viral coat. (auth)

**31267** (Y–1664) STRUCTURAL STUDIES OF CARBON FOAM WITH A SCANNING ELECTRON MICROSCOPE. Schmitt, C. R.; Coffey, A. L. Jr.; Schreyer, J. M. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Feb. 27, 1969. Contract W-7405-eng-26. 24p. Dep. CFSTI.

A scanning electron microscope was used for direct examination of structural features and surface topography of low-density carbon foams and thermosetting resins from which these foams were made. Hole and indentation-type structural defects were found that were more prevalent in the weaker foams examined. (auth)

**31268** (Y–1668) STANDARD LEAK TEMPERATURE CONTROLLER. Henson, F. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). May 4, 1969. Contract W-7405-eng-26. 46p. Dep. CFSTI.

Standard leaks with leak-rate values of $1 \times 10^{-5}$ cubic centimeters of volume per second or less require permeation leak-rate elements. To achieve the desired stability of standard leaks in this range requiring permeation elements, a standard leak temperature controller was developed. The electronic circuit which was designed, constructed, and tested for use in controlling the standard leak temperature included a differential amplifier with a thermistor bridge input, a single-phase silicon-controlled rectifier with a unijunction transistor trigger to phase control the 110-volt, 60-Hertz power applied to a resistance heater, a power supply, and an independent temperature measuring bridge. Of the several possible methods considered for controlling the unijunction transistor trigger angle, the shunt control transistor method was selected due to its high gain at minimum output. (auth)

**31269** SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY (SUB-COMMITTEE D): MINUTES OF EVIDENCE 17th AND 24th APRIL 1969. HC Paper 238 (i and ii). London, Her Majesty's Stationery Office, 1969. 44p. 4s. each part.

These papers relate to the proposed reorganization of the UK nuclear industry. (UK)

**31270** PLUTONIUM-DOKUMENTATION: MIT ANHANG TRANSPLUTONIUM-ELEMENTE. Februar 1969. Band 3, Heft 2. 192 Referate (Register-Nr. 326-735). (Plutonium-Documentation: With Appendix on Transplutonium Elements. Vol. 3, No. 2, 192 References (No. 26-735). Karlsruhe, Ger., Gesellschaft fuer Kernforschung M. B. H., 1969. 116p. DM 578.-. (In German and English).

One hundred and ninety-two references, with abstracts, are presented under the following headings: physical properties of plutonium, its alloys, and compounds; chemistry of plutonium and its compounds, reprocessing and isotope separation; alloys and metal–metalloid systems with plutonium; production of plutonium by nuclear reactions; working with plutonium; and uses of plutonium. (M.C.G.)

**31271** INTERNATIONAL SYMPOSIUM ON MACROMOLECULAR CHEMISTRY HELD AT PRAGUE, AUGUST 30–SEPTEMBER 4, 1965. PART 8. Mark, H.; Overberger, C. G.; Fox, T. G. (eds.). J. Polym. Sci., Part C, No. 16, 4259–4727 (1969). (In several languages). (CONF-650801–(Pt.8)).

Forty-six articles are included; abstracts were prepared for four. The remaining 42 articles contain information on: dynamic properties, pregelification and rheologic behavior, structure, fractionation and molecular distribution, ir spectra, creep, thermal stability, chlorination, electron microscopy, and dilatometric studies on polymers and copolymers; magnetic susceptibility studies in order-disorder phenomena in polymers; polymerization by ionic coordinated and π-allylic catalysts; radical and anionic polymerization; ferrocene-containing polymers; hydroperoxide and peroxy radicals in PVC; two-step copolymerization; organic semiconductors; transport of cationic depolarizers through polybase monolayers adsorbed on the mercury surface; effects of pressure in solid state polymerizations; lithium organyl-initiated polymerization; three thermistor ebulliometer; polyaddition and polycondensation; new monomers involving N and S and their polymers; conformation analysis; structure and flexibility of stereoregular macromolecules; carborane polymers; thermostable polymers; effects of solvents on polymerization; cyclopolymerization of unconjugated dienes; and modification of polymers by epoxidation. (P.C.H.)

*For abstracts of individual papers see: 28849, and 28926–28928.*

**31272** PROGRESSO SPAZIALE. I PROGRAMMI SPAZIALI NEL PROSSIMO DECENNIO. ATTI UFFICIALI DELL'VIII CONVEGNO INTERNAZIONALE TECNICO SCIENTIFICO SULLO SPAZIO, 1–3 APRILE 1968. (Space Progress. The Space Program of the Next Ten Years. Official Actions of the VIII International Conference of Technical Societies on Space, Rome, 1–3 April 1968). Roma, XV Rassegna Internazionale Elettronica, Nucleare, e Teleradiocinematografica, 1968. 560p. (CONF-680457).

Programs and activities of European, U. S., Soviet, and Australian organizations in space communications, medicine, physics, vehicles, power supply, and propulsion are reviewed, and projections are made for anticipated activities over the next 10 years. A separate abstract was prepared for one paper on nuclear power source developments. (H.D.R.)

*For an abstract of the individual paper see: 31215.*